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PRODUCT ENGINEERING

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A McGRAW-HILL PUBLICATION

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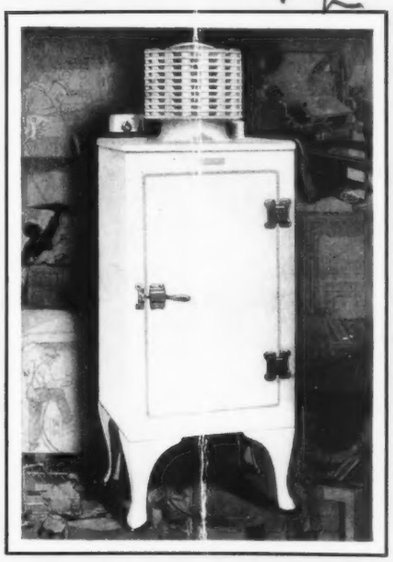


A HOUSEHOLD MACHINE
DESIGNED TO MEET SERVICE CONDITIONS

+ + +

How Cadillac-LaSalle Engineering Is Organized

Worm Gear Drives

Applied Art in Metal Products

+ + +

Buckingham · Steenstrup · Barrett · Petersen · Vanick

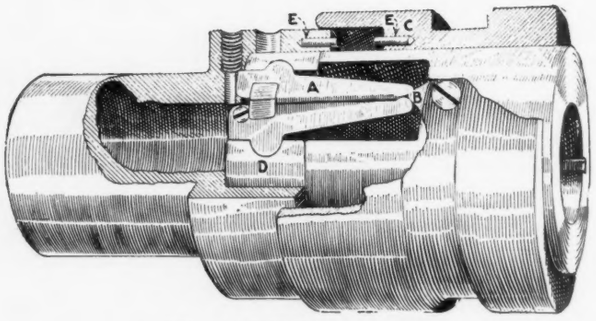
THE JOHNSON FRICTION CLUTCH

ALL PRODUCT ENGINEERS

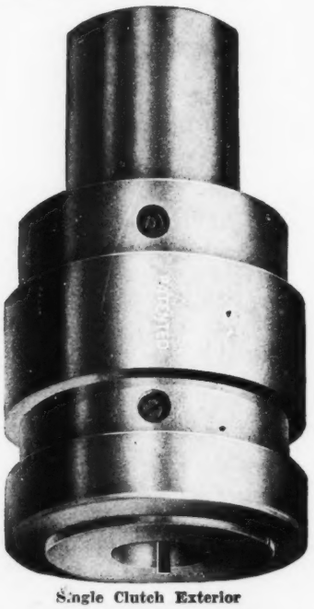
Should become acquainted with the

IMPROVED

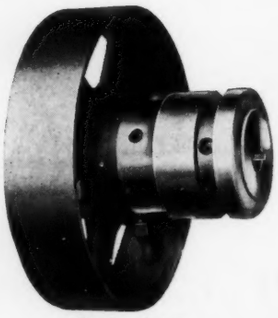
JOHNSON FRICTION CLUTCH



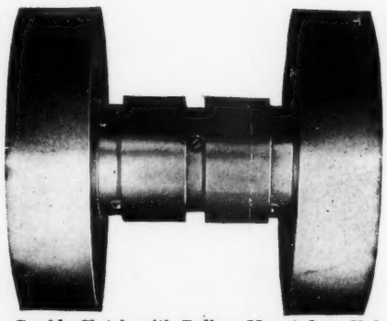
Johnson Single Clutch sectioned,
Showing Simplicity of Construction



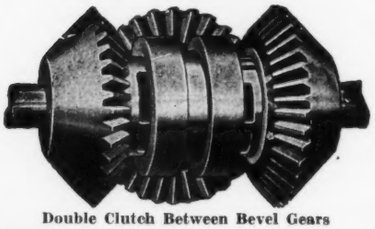
Single Clutch Exterior



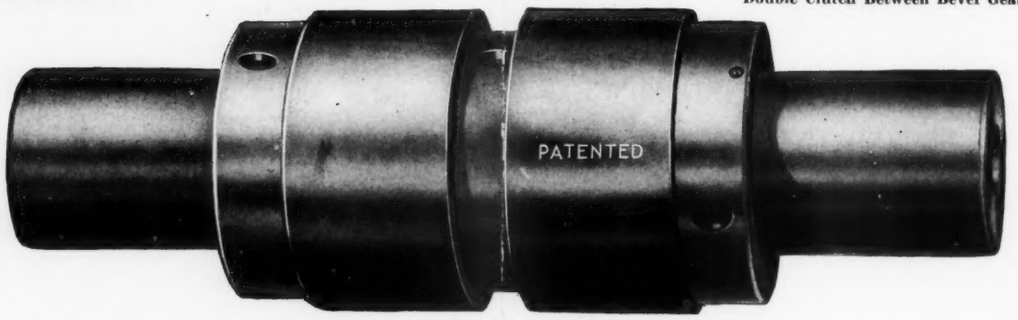
Single Clutch,
Pulley Mounted



Double Clutch with Pulleys Mounted on Hubs



Double Clutch Between Bevel Gears



Double Clutch Exterior

WIRE, PHONE OR WRITE FOR CATALOG "PE—1"

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER, CONN.

PRODUCT ENGINEERING

A McGRAW-HILL PUBLICATION

New York, January, 1930

GERARD SWOPE

DESIGN OF THE GENERAL ELECTRIC REFRIGERATOR

MACHINES that are sold for use in the home should be built according to rigid specifications because of the fact that their performance must prove satisfactory under unusual conditions. Careful engineering and expert construction are necessary to meet the requirements of moderate cost, limited space, durability, and quiet and automatic operation with practically no attention either from the user or from field men trained to give service.

The General Electric refrigerator is eminently an engineering job. It is a tribute to the skill of our engineering staff, as well as to our manufacturing and sales organizations, that we have met these requirements and that today more than 350,000 of these machines are in successful operation in homes of every class.

President,
General Electric Company

A HOUSEHOLD MACHINE

Designed to Meet Service Conditions

By C. STEENSTRUP

Engineer, Refrigeration Department, General Electric Company

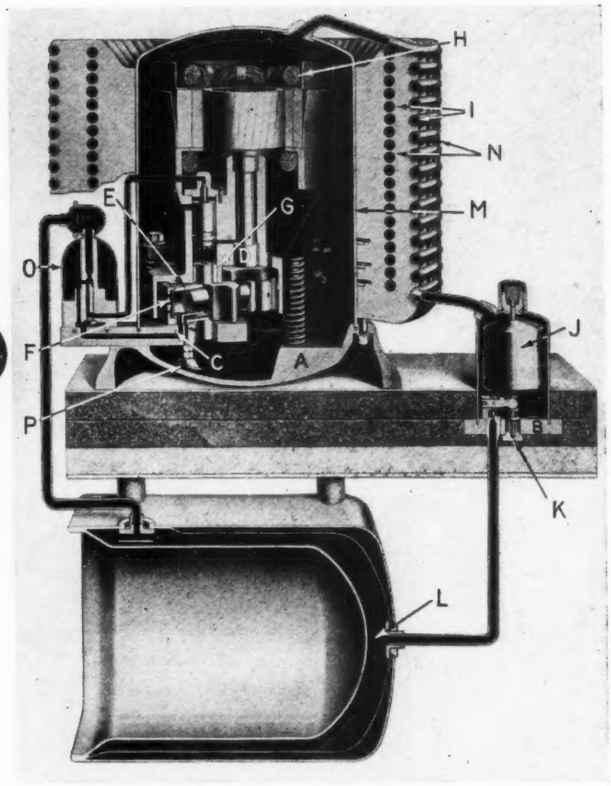


FIG. 1 — CUTAWAY VIEW, partly diagrammatic, of the mechanism of the General Electric refrigerator, illustrating the following, among other parts:

A—Machine Base	**I—Condenser Coils**
B—Float Base	**J—Float**
C—Bearing Plate	**K—Float Valve**
D—Crankshaft	**L—Evaporator**
E—Cylinder	**M—Casing**
F—Disk Valves	**N—Fins**
G—Trunnion bearing	**O—Surge Chamber**
H—Motor	**P—Oil Strainer**

COMBINING a compressor, an evaporator, and a condenser to make a satisfactory refrigerating unit is not a new problem. There are, however, numerous difficulties in the design and production of such a machine for domestic applications. Hundreds of companies have attempted to place units on the market, but today only three or four manufacturers are doing more than 75 per cent of the business.

A manufacturer of domestic refrigerators must meet exacting requirements both in design and in production. The unit must require a minimum of service and attention, and be easy to install, simple, automatic, and free from troubles such as might easily occur through careless or ignorant handling. It also must be and remain sanitary, quiet, and efficient in operation. Attractive appearance also is a decided asset.

Other desirable, if not essential, qualities include absolute sealing to prevent loss of gas and oil, to exclude dirt, and to preclude tampering or tinkering with the mechanism. Service in the field should be limited to control adjustments. The unit also should be compact, so that maximum space for useful refrigeration storage is left, should be free from vibration, and should function electrically so that there is no interference with any radio installation. It is necessary, moreover, that the unit be capable of production at moderate cost in order to meet competition and extend the market.

To satisfy these requirements involves the solution of some difficult and absorbing problems, as will be evident from an examination of the design evolved by the General Electric Company. To grasp these problems it is necessary, of course, to keep clearly in mind how a refrigerating machine functions.

The suction side of the compressor is connected to the evaporator, in which it maintains a low pressure, thereby allowing the liquid refrigerant to evaporate at a low temperature. The vapor is discharged from the compressor to the condenser under pressure. Here the compressed vapor dissipates heat and consequently liquefies. The liquid is fed back into the evaporator by means of a float valve to complete the cycle.

In the General Electric design the refrigeration process is carried out by the mechanism shown diagrammatically in Fig. 1. The design presents a number of important advantages and solves several of the problems outlined above in an original and effective fashion. The measure of success attained by this unit is attributed in large part to the noval features incorporated in the design.

To assure silent and dependable operation and long life a correct choice of materials was an important part. The designer also had to keep in mind, at the same time, the

requirement of compactness. Steel is used in all cases where it is necessary to hold pressure. The machine base, float base, bearing base and the crankshaft are forgings. The cylinder is of close-grained cast iron. All main bearings are of hardened and ground steel. The discharge valve is of high-carbon spring steel ground on the face. The cylinder trunnion bearings, which are subjected to a low rubbing speed, are of special bearing bronze.

A decided simplification as compared to many machines for similar purposes was effected in the design finally developed. By placing the motor inside of the compressor housing and connecting it directly to the compressor, all stuffing boxes and belt connections are eliminated. This eliminates the possibility of refrigerant leakage through a stuffing box and also eliminates the service attention ordinarily required when the parts mentioned are employed.

Putting the entire mechanism inside a sealed container has other advantages. It cannot be tampered with, and the same seal that keeps refrigerant from leaking out also prevents the entry or air, dirt, and moisture, three important agents of deterioration. Moreover, oil cannot leak out, is never over-heated, cannot become contaminated with dirt and dust, cannot oxidize, and cannot evaporate. Neither is it affected by the refrigerant.

All this tends to eliminate the need for service. Since all units are assembled completely and thoroughly tested at the factory, no assembly or repair work is done in the field. This, in turn, enables the distributing organization to devote practically its entire time to selling, rather than to servicing and mechanical details.

With a design of this character it was necessary, not alone to select the best materials, but to build and test the mechanism with extreme care, so that use without attention could be assured over long periods. This placed a heavy responsibility upon the manufacturing department, but it was met so well that a two-year guarantee on all units could be given. Many of the hundreds of thousands of units installed in homes to date have been in service for more than two years, but not a dollar has been paid out by any user for repairs to parts of the machine.

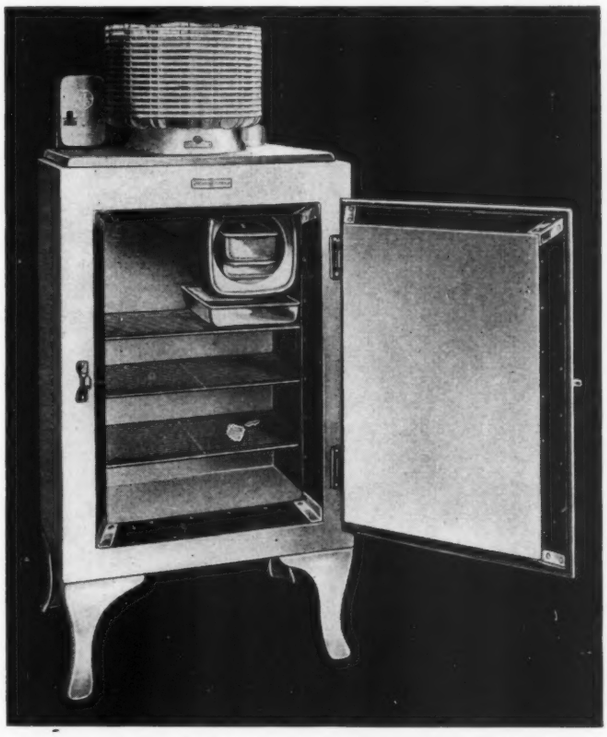


FIG. 2—THE COMPLETED PRODUCT. All parts described in the text are carried on the plate which forms the removable top of the refrigerator

A description of the completed product will facilitate a better understanding of the way in which the design was evolved. The complete unit, mounted upon a base which forms the top of the refrigerator cabinet, includes the following essential parts:

1. The compressor unit, consisting of the compressor, the motor, and the frame on which they are mounted, together with the various auxiliary piping.
2. Condenser. This consists of copper tubing wound around the steels fins on the compressor case.
3. Float valve.
4. Evaporator.
5. Control.

The evaporator at all times is almost filled with liquid refrigerant. The principal function of the compressor is to compress the refrigerant vapor and to discharge it into the compressor case from which it goes to the condenser coil where it gives up heat and is liquefied. The liquid refrigerant then is fed back into the evaporator through the float valve. Another function of the compressor is to maintain a low pressure in the evaporator so that the liquid refrigerant can evaporate and absorb heat or, in other words, produce refrigeration.

To minimize the transfer of any noise or vibration to the outside casing, three vertical springs support the compressor assembly. The motor, which is of the single-phase induction type, is very simple. It has no brushes or sliding contacts, hence it does not interfere with radio installations. The rotor is pressed onto the main shaft. This shaft itself is of high-grade steel casehardened, heat-treated, and ground on a centerless grinder.

The main frame, shown clearly in Figs. 3 and 4, is a semi-steel casting. It is normalized when received from the foundry and again after the rough machining. Case-hardened bushings for the shaft are pressed into the main frame at a temperature of about 325 deg. F. After the main frame is machined these bushings are ground to a tolerance of plus or minus 0.0001 inch. The upper bushing takes the thrust load of the rotor as well as radial loads.

In operation the compressor functions as follows: As the piston is moved in and out of the cylinder by the action of the crankpin, the cylinder is made to oscillate about its trunnions. The cylinder rides on the steel bearing plate, and its oscillation opens and closes the suction port and the oil ports. The compressor discharges past a disk valve which covers the head of the cylinder and is backed up by two disk springs. A muffle box holds the valve assembly in place.

For the cylinder itself, shown separately in Fig. 5, a semi-steel, or high-test iron casting is employed. The piston has no rings, but is honed to a tolerance of plus 0.0003 in. on a 1-in. diameter. The piston and cylinder are lapped together to insure as nearly perfect a fit as possible.

The piston, which is hollow and has a wall thickness of $\frac{1}{16}$ in., is machined from rectangular steel bar stock. A cap is hydrogen-brazed onto its outer end. The bushing

in the end of the piston in which the crankpin operates is casehardened, heat-treated and ground. It will be noted from Fig. 5 that there is a small oil piston mounted on the main piston base beside the main piston.

This piston is turned from solid bar stock. It fits into a cylinder drilled into the same iron casting that forms the main cylinder of the compressor. The ports for the piston pump register with corresponding ports in the bearing plate against which the trunnioned cylinder rests. With this arrangement, the number of parts required for the pump is reduced to a minimum, no small valves are required, and the design, as a whole, is simplified.

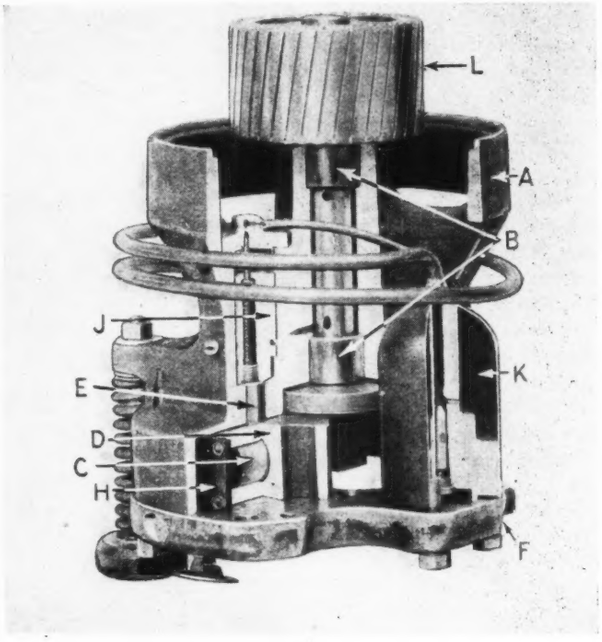
The compressor operates at 1,750 r.p.m., which is the rated speed of the motor. By using this speed and providing an unloader, a very small motor and a small direct-connected compressor can be employed with resultant simplicity and compactness.

One of the unique features of the compressor unit is that it never requires renewal of the oil supply after it has left the factory. A permanent supply of high-grade mineral oil is placed in each unit at the factory, and since this oil never is overheated and cannot become oxidized, mixed with dirt or evaporate, there is no need to replace it.

A simple force-feed system furnishes all moving parts with a liberal supply of this oil. The small oil piston sucks oil from the base sump and forces it around the main piston so that the latter is operating constantly in a ring of oil under pressure. From this cylinder oil is forced upward to the unloader, main bearings, and crankpin, after which it spills back into the sump in the base. An oil pressure of 4 to 5 lb. is maintained at every bearing point. This insures complete lubrication.

The oil pressure also operates an unloader (shown above the cylinder trunnion in Figs. 3 and 4), which equalizes the pressure on both sides of the main piston whenever the unit stops, thereby reducing the starting torque, and permitting the use of a smaller motor than otherwise would be required. When the unit is running, the oil pressure forces the unloader plunger upward, thereby closing a small by-pass valve. As soon as the unit stops, the oil pressure decreases, permitting the unloader plunger to drop, thereby opening the by-pass valve. This allows compressed vapor to enter the suction side of the pump. The rush of compressed vapor also closes a check valve, so that the vapor cannot go back into the evaporator. When the unit starts again, the by-pass valve is closed by the unloader being forced upward by the oil pressure, the check valve drops open, and the unit resumes normal operation.

The steel casing (Fig. 1) which covers the compressor unit is drawn in two operations from sheet stock. Sheet-steel fins are line-welded to the outer surface of this case.



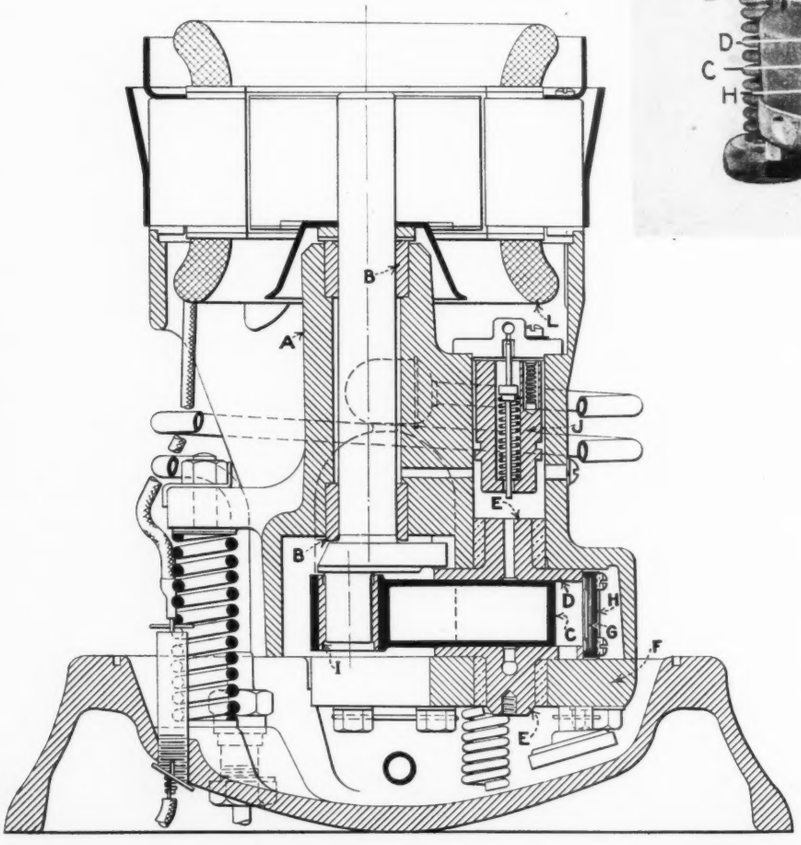


Fig. 3—(above) and Fig. 4—(at left) show sectional views of the compressor and other units within the sealed casing. The same reference letters designate the same parts in both figures, as follows:

A—Main Frame
B—Crankshaft bushings
C—Piston
D—Cylinder
E—Cylinder Trunnion
F—Bearing Plate
G—Disk Valve
H—Muffle Box
I—Piston Bushing
J—Unloader
K—Surge Chamber
L—Motor

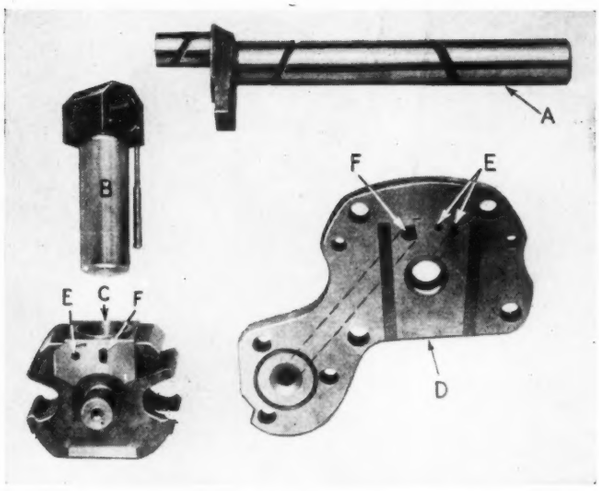


FIG. 5—COMPRESSOR PARTS: A, crankshaft; B, piston assembly, showing small oil-pump piston; C, trunnioned cylinder; and D, plate against which the cylinder bears. E indicates oil-pump ports, and F gas-compressor inlet ports. The dotted lines indicate connecting passages

These fins provide surface for the dissipation of heat and form a support for the copper condenser tubing. In some early forms of the machine this casing is bolted to the drop-forged base by means of 16 bolts, a tongue and groove joint with a soft aluminum wire gasket being used to make the joint tight. In other models the casing is welded to the base in order to obtain a more positive seal.

All parts of the unit that are required to hold vapor under pressure are designed with a minimum safety factor of 20. Although intended to carry vapor pressures of less than 100 lb. per sq.in. a shop test at 500 lb. per sq.in. is given the welded evaporator shell.

In the center of the surge chamber is located the Monel metal check valve referred to above. Although Fig. 1 shows the surge chamber outside of the compressor casing, it actually is located within the casing, as shown in Fig. 3, being mounted on the steel base plate and connected by a passage in this plate with the inlet port of the pump. A copper tube leads from the base of the surge chamber to the fitting which contains the seat for the unloader valve.

The surge chamber assembly, shown in Fig. 1, is made mostly of screw-machine parts and stampings. Several of the joints are brazed together. The strainer is chromium plated to prevent copper from running into it during the brazing operation. All parts are pickled to insure cleanliness prior to brazing.

THERE are only three important elements of the complete machine outside the compressor chamber: the float chamber, the evaporator or chilling unit, and the control unit. Compressed vapor delivered into the compressor casing flows out of the top of this casing, through air-cooled coils, where it is condensed and flows into the float chamber.

This chamber has a drawn-steel case containing the float, the lower end of which engages with the pressed-metal lever which operates the float valve. When the liquid reaches a predetermined level, the valve is raised from its seat and some of the liquid is discharged into the evaporator. When the liquid level falls, the valve again closes. This assembly is another good example of construction from stampings and screw machine parts in which joints are brazed.

From the float chamber the liquefied sulphur-dioxide refrigerant flows into the evaporator, which is interesting both from a design and production standpoint. It is made of three drawn-steel sections nested together to form two compartments. The inner compartment is for the refrigerant, while the outer compartment is for a 40 per cent potassium carbonate freezing solution which acts as a cold storage, or "balancer."

All three steel shells are joined into a gas-tight connection at their open end first by welding and then, as an additional precaution, by hydrogen brazing. In this process, after the joint to be brazed is first made mechanically tight by welding, it is covered with copper oxide, and when possible, a piece of copper wire is wrapped around it. The next step is to place the piece to be brazed in a hydrogen furnace, where the oxide is reduced and the copper flows into the seams to form a solid joint. This process is especially adaptable to making internal welds. A large number of the joints in various parts of the refrigerator are made by this brazing process. All joints in liquid or gas connections that are not brazed or welded are made with silver solder having a high melting point.

Following final assembly, each unit is completely evacuated and dried out before it is charged with refrigerant. After being charged each unit is operated in a 100 deg. F. temperature at which it must refrigerate satisfactorily. Following this test, each unit is placed on "running storage" for 24 hours as a final check before it is painted and shipped.

With this description in mind it is instructive to note to what extent the finished product fulfills the objectives sought in laying down the design.

Complete inclosure and sealing, together with extreme care in construction to close limits, the use of hardened parts, positive lubrication, and direct drive tend to reduce service requirements to a minimum. In addition, the mechanism is tinker-proof and is not easily put out of service by careless or inexpert handling, while leakage of oil and refrigerant is effectively prevented.

INSTALLATION merely involves placing the ready-mounted unit in position and plugging the connecting cord to a suitable electric outlet. Operation is completely automatic, and is made efficient and approximately noiseless by accurate machining, while careful balancing and spring mounting has reduced vibration to a minimum.

Since all exposed parts of the unit are of metal, easily cleaned and tightly sealed, the unit meets sanitary requirements. In addition the appearance of the unit is satisfactory while the space occupied is small. Since the motor is an induction type without commutator, sparking and interference with radio apparatus is avoided.

Moderate cost has been assured, despite the high grade of material and workmanship required, by a design which lends itself to ready production in large quantities. Stampings and screw machine parts are used wherever feasible, while other parts also can be turned out by rapid and economical production methods. Modern methods of brazing and welding are used extensively, special jigs and fixtures being employed wherever practicable for this work.

Thus it would seem that the requirements formulated before preparing the design all have received adequate attention. There has been no attempt to describe the cabinet nor the automatic thermostat control of the machine, the present discussion being limited to the mechanical refrigerating apparatus itself.

How Cadillac-LaSalle Engineering Is Organized

E. W. SEAHOLM, Chief Engineer

By HERBERT CHASE

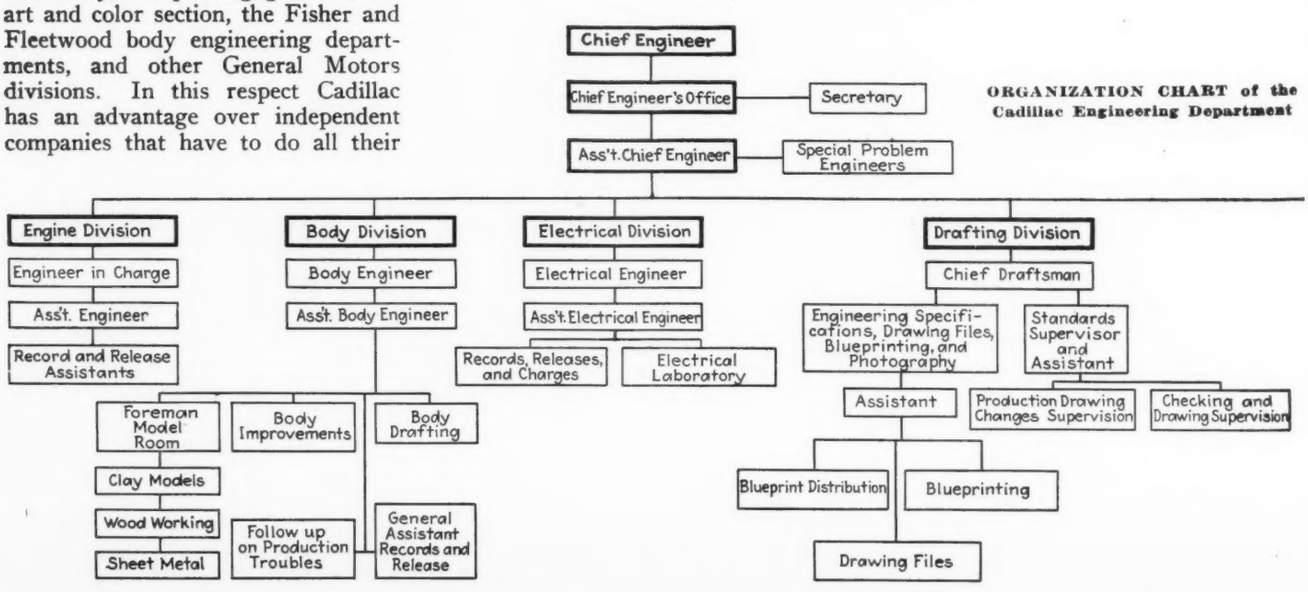
Associate Editor, Product Engineering

MUCH progress has been made by the Cadillac Motor Car Company's engineering department in organizing its work so that it will not only function in close co-operation with the manufacturing department and still keep pace with advanced engineering practice, but will follow a logical budget system intended to avoid unduly expensive experimentation.

The Cadillac organization is one of the numerous units of the General Motors Corporation and thus gains many benefits from co-operation with other units such as the research laboratory, the proving grounds, the art and color section, the Fisher and Fleetwood body engineering departments, and other General Motors divisions. In this respect Cadillac has an advantage over independent companies that have to do all their own basic research, and have to depend largely upon the experience of their own staff of engineers. On the other hand, the same circumstances impose limitations. Although most of the LaSalle chassis, excepting the engine, is built in a plant separate from the Cadillac plant, all designing and other engineering work is handled by the Cadillac engineering department.

At the head of the Cadillac engineering organization is the chief engineer. Acting between him and the seven main divisions of his staff, is the assistant chief engineer. In addition to the heads of the seven divisions who answer to the chief engineer, there are three engineers who are assigned, as occasion requires, to special problems, and who report direct to the chief engineer. The total number of employees in the engineering department is somewhat in excess of three hundred.

By reference to the accompanying chart of the Cadillac engineering organization, it is readily seen how the various lines of work are distributed among the seven divisions, but many of the details merit specific notice. Each division is headed, of course, by an engineer with long experience in his particular line of work. Under this engineer are as many assistant engineers, foremen, testers,



ORGANIZATION CHART of the Cadillac Engineering Department

Seven divisions handle the design, construction, tests, and development of complete cars and parts, subject to a budget control

W. R. STRICKLAND,
Assistant Chief Engineer

mechanics, and other employes as are needed for the particular tasks in hand. In the engine division, for example, the engineer in charge has two assistant engineers besides the required number of clerical assistants. This division is charged with the complete design and experimental production of current and future models of power plants, exclusive of carbureters and electrical units. It has special design rooms in which the necessary degree of secrecy regarding new designs can be maintained. Layout men, draftsmen, checkers, and tracers are secured from the drafting division by special assignment, but remain under that division for disciplinary and administrative control.

Work undertaken by the body division includes the design, equipment (excepting instruments), finish, and test of all types of bodies for current and future models. This work is done, however, in close co-operation with the Fisher and Fleetwood engineering departments and with the General Motors art and color section. In addition this division maintains close contact with body production units, follows up service and production troubles, and handles the usual records, releases, changes, and cancellations pertaining to all body models.

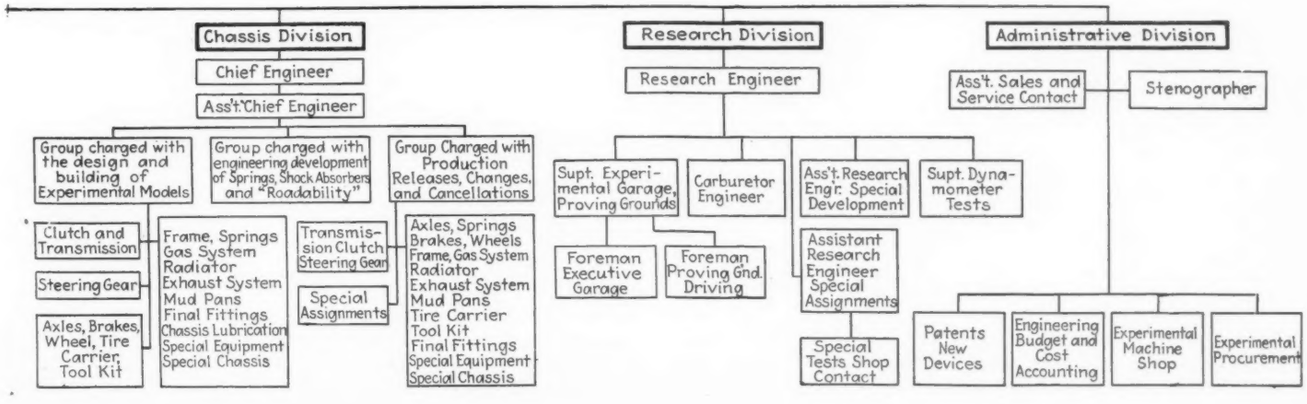
Body draftsmen are procured from the drafting division on the same basis as that applying to the engine division, already mentioned, and the same arrangement applies to other divisions charged with design items. Whenever possible, draftsmen experienced on certain classes of work are assigned more or less permanently to divisions in which this experience can be used to best advantage. The drafting division, headed by the chief draftsman, besides providing other divisions with men for layout, design, and drafting work, handles also the routine work involved in making changes on drawings and keeping files of such drawings up to date. Blueprint packs are prepared and furnished as needed throughout the plant, as well as by mail to the Canadian plant in Oshawa and to other General Motors divisions, as occasions requires. The purchasing department also is supplied with such drawings as are required by purveyors who furnish parts and equipment for use in Cadillac and La Salle cars.

Another important function of the drafting division is performed by its record and specification section which prepares, distributes and maintains car parts lists; prepares material specifications and standards; and issues releases, changes, and cancellations on all chassis and body parts.

CONSTANT liaison between the engineering department and the tool design division of the production department, makes it easy to effect such changes as can be made to facilitate manufacture without affecting the desired performance characteristic in the parts involved. These changes, of course, are subject to approval by the engine, body, or chassis division, under supervision of which they are carried out in the manufacturing plant.

In the chassis division work is carried forward on nearly all chassis parts outside the powerplant, in much the same way as that done by the engine division. The chassis division is charged with the design and construction of experimental chassis and with testing them through and with the assistance of the experimental garage and laboratory. In this division is a special group, the particular duty of which is the development of parts, such as springs and shock absorbers, which have a direct bearing upon the "roadability" or "riding qualities" of the car. Other subdivisions of the work of this division are apparent in the organization chart.

The only remaining division directly concerned with design is the electrical division which is responsible for the design, testing, produc-


Chassis Division
Chief Engineer
Ass't. Chief Engineer
Group charged with the design and building of Experimental Models
Group charged with engineering development of Springs, Shock Absorbers and "Roadability"
Group Charged with Production Releases, Changes, and Cancellations
Clutch and Transmission
Steering Gear
Axles, Brakes, Wheel, Tire Carrier, Tool Kit
Frame, Springs Gas System Radiator Exhaust System Mud Pans Final Fittings Chassis Lubrication Special Equipment Special Chassis
Transmission Clutch Steering Gear
Special Assignments
Axles, Springs Brakes, Wheels Frame, Gas System Radiator Exhaust System Mud Pans Tire Carrier Tool Kit Final Fittings Special Equipment Special Chassis
Research Division
Research Engineer
Supt. Experimental Garage, Proving Grounds
Carburetor Engineer
Ass't. Research Engr. Special Development
Supt. Dynamometer Tests
Foreman Executive Garage
Foreman Proving Gnd. Driving
Assistant Research Engineer Special Assignments
Special Tests Shop Contact
Administrative Division
Ass't. Sales and Service Contact
Stenographer
Patents New Devices
Engineering Budget and Cost Accounting
Experimental Machine Shop
Experimental Procurement

tion follow-up and installation of all electrical equipment and instruments. This division maintains close contact with the Delco-Remy and North-East Divisions of General Motors, which furnish most of the electrical equipment, as well as with the central General Motors Laboratory. It has its own laboratory for tests of electrical equipment.

Turning now to the question of tests, it is evident that the research division embraces a number of important activities. It operates the experimental garage, which assembles experimental chassis, prepares all cars for road and proving ground tests, and checks, through its drivers, and in co-operation with the engineers of other divisions, the results secured in the various tests conducted.

In the engine laboratory, under the superintendent of dynamometer tests, comprehensive tests of engines, axles and other parts are conducted.

In general, mechanics are assigned to work on Cadillac and LaSalle cars or parts in accordance with their experience; and mechanics who have specialized on particular units or assemblies are retained on that class of work so far as feasible. Drivers are paired to permit of continuous day and night driving when required.

One Assistant Research Engineer is assigned to special research investigations or tests, and a second contacts with the shop with a view to clearing up any difficulties which arise in production cars.

It should be added that the engineering department maintains close and frequent contacts with field service men who report promptly any troubles that are being encountered with Cadillac and LaSalle cars in service throughout the country. Energetic steps then are taken to prevent similar trouble on future cars. This contact work, which extends to the sales as well as to the service organization, is handled through the administrative division, which, although last on the list, is far from being least in importance.

THIS division has direct control over the experimental machine shop, and over sections devoted respectively to procurement, patents, technical data, stenography and filing, and budget. The machine shop makes practically all parts used in constructing experimenatl chassis and units thereof, but frequently secures assistance from Cadillac production shops when some of the machining operations on the new part under construction can be done more economically on regular production tools. In the patents and new devices section are handled all matters pertaining to patents and to new devices submitted from outside sources. This work is done in co-operation with the General Motors patent section and the new devices committee.

The experimental procurement section is charged with assigning work to certain other sections and to the purchase, storage, and issue of experimental material and parts. Work for the experimental machine shop usually is assigned through an experimental procurement section order. Stenographic work is handled from a central office and there is also a central filing system for engineering reports, technical data, and reference material. This filing is done in a room adjacent to the general engineering offices, where files of current engineering periodicals and reference books also are maintained.

An important function performed by the administrative division is to formulate an engineering budget and to keep proper accounting records. This work is done by the budget section in co-operation with the main accounting office of the company. Its purpose is to assure proper study of requests for funds for engineering and experimental purposes and to make certain that the true cost of expenditures on this account is recorded properly and reflected in company records. It is realized, of course, that it is an extremely difficult matter to predict the cost of experimental work. Partly for this reason, and also because in the past records seldom have been kept in such a way as to reflect the true cost of specific items of experimental work, definite steps have been taken to assure the compilation of such records. From these, it is hoped, it will be possible in time to make more intelligent estimates of the cost of such work. In any case, there will be some specific data for the guidance of those who must decide in which projects the advantages anticipated are commensurate with the probable cost.

SUPPOSE, for example, an engineer must decide whether it is worth while to try out a new type of piston. If past records show that similar tests have cost, let us say, from $1,200 to $2,000, the engineer is in a much better position to say whether the possible advantages to be gained by use of the new type are well worth such a sum than he would be without any specific data.

To facilitate proper cost accounting, most employees of the engineering department not charged with general or supervisory duties are required to allocate their time to specific engineering work orders. To secure an appropriation for a project, a formal request, signed by the engineer in charge of the project, must be filed by him with the engineering budget supervisor. The form employed has spaces for the date and number of project, its subject, its estimated cost in direct labor and material, data on expenditures for related items in the current and prior years, the scope of the project and whether it is for current or future production models, the nature of project, why it is desirable, and a technical description of the work required. When this request has been approved by the chief engineer, suitably numbered work orders and material requisitions are issued, and the resulting expenses are charged against the specific appropriations. The accounting department then makes a monthly report on each project in hand showing the cost to date and the approximate degree of completion. If the cost exceeds estimates, a supplementary request for further appropriations must be filed.

The accounting department has created what is termed a "burden center account" to which are charged certain indirect items, such as supervising engineers' salaries, for later distribution among the various projects on the basis of labor (including direct salaries and wages) charged to the respective projects during the month.

By a study of the monthly report the chief engineer can determine how much each project has cost to date and how near it is to completion. In the event that the cost seems likely to prove out of proportion to the benefits which the project is expected to produce, it is quite likely to be abandoned. In any event, the accounting enables the department head to keep advised of the cost of various projects and, thus, to curtail some and perhaps increase others in such a way as to secure the greatest benefit from a given total expenditure.

WORM GEAR DRIVES

Fundamental Considerations In Their Design

By EARLE BUCKINGHAM
Associate Professor of Mechanical Measurements, Massachusetts Institute of Technology

In this introductory article of a series, the author sets forth some of the peculiar characteristics of worm gear drives, and tells wherein they differ fundamentally from other types of gearing. He also points out how an exact solution of the problems pertaining to pitch, methods of milling, and lubrication may be obtained by a study of the geometric properties of the warped surfaces of the generated worm thread

DESPITE their widespread use for a long period of years, data in regard to the most effective design of worm drives and their load-carrying abilities and efficiencies are very incomplete and often seemingly contradictory. Even in textbooks that treat the design of machine elements with much detail, this subject is disposed of very briefly. Periodic literature on this subject offers but little information, as the contributions are usually brief and seem to bear little relation to each other.

A very little study of this subject makes apparent the difficulties that exist in analyzing the contact conditions between a worm and a worm gear. The warped surfaces of the worm are not the simplest with which to deal. In addition to this, the surfaces of the teeth of the worm gear, which must be conjugate to the warped surface of the threads on the worm, introduce further complications.

Most previous analyses of these surfaces have considered primarily the conjugate action between sections of the worm thread parallel to its axis and the corresponding sections of the worm gear, treating these sections as racks driving a spur gear. Furthermore, the forms of these sections have usually been established by descriptive geometry, which requires careful and painstaking draftsmanship to obtain accurate results. Notable among such contributions have been Ernst's "Treatise on Worm Drives," published in Berlin in 1901, and Robert A. Bruce's paper on "Worm Contact," presented in 1906 in London before the Institution of Mechanical Engineers.

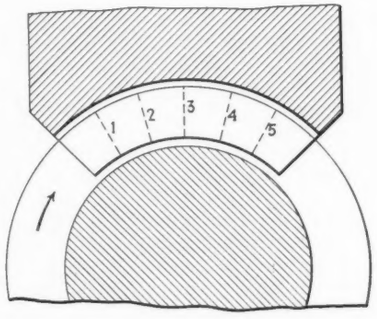
Because of the time and effort required to analyze the warped surfaces of worm threads, consideration is given primarily to the conjugate action between an axial section of the worm thread and the corresponding throat section of the worm gear. This gives an incomplete and often erroneous measure of the contact conditions across the face of the worm gear because of the changing form of the worm thread section, this change being controlled in large measure by the lead angle. In addition, this conjugate action itself is but a small part of the whole problem. In many respects, a worm drive is a specific form of a thrust bearing, complicated by the helicoidal surfaces of the worm thread and by the conjugate tooth surfaces of the worm gear. It also has line contact between the mating surfaces instead of surface contact, thus introducing very high pressure

between the contacting lines, or minute surfaces.

Worm drives are often inefficient. The loss of power is caused by friction. The effects of friction are reduced by lubrication. Therefore, it would seem logical to attack this problem of worm drives primarily as a problem of lubrication. The first step towards this end would be to determine the position and nature of the actual contact lines between the worm thread and the gear tooth surface, and then study them in respect to their influence on the lubrication. Most of the sliding action in these drives results from the rotation of the worm. This sliding is so much in excess of the sliding caused by the conjugate action on the tooth profiles that it would seem the sliding resulting from the rotation of the worm should receive primary attention, while the small amount of sliding that results from the conjugate action would be secondary in importance.

IN SERVICE, the performance of worm drives is often inconsistent. For example, with similar, or even identical worm drives, some prove satisfactory in service while others prove troublesome, often when the nominal loads are less on the troublesome drives than they are on those drives which prove satisfactory. There are several reasons for this. Because of the changing sectional profile of the worm thread, deflection in the worm or worm gear are more detrimental to efficient operation than corresponding deflections in other types of gearing. Furthermore, some worm drives, particularly those with the higher lead angles, are very sensitive to any mislocation of the position of the worm with respect to the face of the worm gear. Definite knowledge of the actual contact between a worm and a worm gear will make it apparent that some contact conditions are less sensitive to mislocation in this respect than are others. In general, the mislocation or deflection which forces the worm to contact with the gear in an improper position across the face of the gear is of greater detriment than a deflection which causes the centers to separate. Conventional worm gears are handicapped in this respect in that their design does not provide much lateral stiffness to the rim of the worm gear. But before the amount and direction of the thrust causing these deflections can be determined, it is necessary first to establish definitely the position of the contact lines between the worm threads and the gear tooth profiles.

In general, the conventional design of worm drives employs much coarser pitches than are generally used for any other types of gearing. As a matter of fact, practice in all types of gearing, except on worm drives, has been progressing constantly towards finer pitches. Both tests and experience have shown that the finer pitches are inherently smoother running and more efficient than the coarser ones, while their actual strength against breaking is better than directly proportional to the circular pitch. Coarser pitches were originally used because, at that time, it was more economical to make gears with as few teeth as possible. The earlier methods of making gears, such as casting the teeth to form and, later, of milling them with a formed milling cutter, resulted in a cost of production more or less proportional to the number of teeth in the gear. Newer methods have resulted in a cost of production dependent more upon the size of the gear and less upon the number of teeth to be cut.

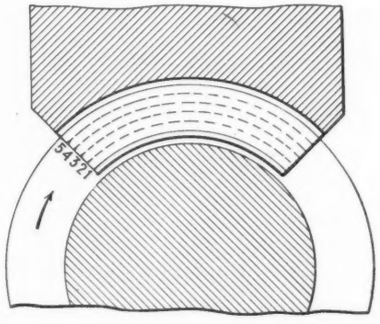


ILLUSTRATING the progression of the contact lines across the face of the worm gear tooth. Upper view, radial line contact; lower view, line contact on arcs of concentric circles. The arrows designate the direction of rotation of the worm; the numerals, the direction of motion of contact lines.

With worm gears, however, except in a few cases of quantity production where special facilities have been developed, the cost of production is still largely dependent upon the number of starts or threads on the worm. It takes nearly twice as long to chase, mill, or grind a double-thread worm as it does to make a single-thread one. Therefore, the coarser pitch of fewer threads, or starts, is generally employed. If the advantages of the finer pitches were more widely appreciated, the increased expense of making them would often be found to be well worth while, and their use would be much more common. In addition, if multiple threads were more widely used, the machine tool industry would soon provide suitable equipment on which to produce them with little, if any, increase in the cost of production.

In addition to all this, the exact form of the worm thread depends largely upon the methods used to produce it. The thread form of a chased worm may be materially different from the thread form of a milled worm. Furthermore, a difference in the diameter of the milling cutter or grinding wheel may also make a material difference in the form of the thread produced, particularly when the lead angle is large.

Worm drives usually require a greater or less period of "running in" before the full load can be applied safely. There are several reasons for this. In the first place, the tooth profile of the worm gear, as it is finished by the conventional hob, is composed of a series of facets, the number depending upon the number of cutting flutes in the hob, so that contact will take place first on the edges of the facets. These facets must be rubbed down by the action of the worm thread against the gear tooth surfaces before full contact can be secured. In the second place, even if perfect surfaces were secured on the gear tooth profiles, the alignment of the worm and gear is probably never perfect. Here again, point contact would exist at the start so that the surfaces of the teeth of the gear must be rubbed down or cold-worked until sufficient contact exists to carry the load, else excessive wear will take place.



If the gear tooth surfaces are reasonably accurate and the material of the gear is sufficiently ductile to cold-work readily, this "running in" will soon serve its purpose. On the other hand, if the inaccuracies are too great, or if their nature is such that they cause excessive cutting or abrasion, small particles of the ma-

terials of the gears will be released into the lubricant and will tend to cut both the worm thread profile and the gear tooth surface. When such conditions exist, it is seldom possible to obtain a satisfactory drive. Here the physical characteristics of the materials used play an important part as does the nature of the lubricant and the nature of the action between the tooth surfaces. Some of the conjugate action has a distinctly polishing effect, while other phases of this conjugate action have pronounced abrasive effects. The solution of this part of the problem of worm drives requires a study of the physical characteristics of materials, particularly with respect to their ductility, or ability to be cold-worked without disintegration. It requires also a study of friction, lubrication, and the nature of the conjugate action across the face of the worm gear and the resulting contact conditions existing in the drive.

THE contact conditions on worm drives may be such as to promote lubrication, or they may be such as to tend to prevent it. In general, it would appear that the lubricant carried on the surfaces of the worm gear teeth would be much more effective than that carried on the surfaces of the worm threads, because the lubricant on the worm-gear teeth will be pushed ahead of the contact line so that the contact would tend to ride on a wedge of lubricant, while the oil carried on the surfaces of the worm threads would tend to be scraped off behind the contact line, although some of it may find its way in between the contacting surfaces. Oftentimes, better operating conditions are secured when the worm is mounted above the gear with the rim of the gear immersed in the lubricant than when the worm is mounted below the gear with the worm threads immersed in the lubricant. For intermittent drives, where the worm is stopped and started frequently, possibly the conditions are best when the worm is mounted below the gear.

Viewing the worm drive as a thrust bearing, with reference to the lubrication only, the ideal contact conditions would be to have the contact between the worm threads and the gear teeth as radial lines on the worm as shown in the upper portion of the accompanying figure. The direction of the travel of this radial line of contact is designated by the consecutive numbering of the lines, the direction of rotation of the worm being shown by the arrows. This would result in a condition similar to that on a Kinsbury thrust bearing where a wedge of lubricant is carried along just ahead of the contact line. The contact line in the worm gear would extend across the worm thread from top to bottom, thus insuring practically uniform wear conditions over the entire tooth profiles. This is of prime importance in worm gear design, as not only does failure usually occur on account of excessive wear, but the efficiency of the drive is also greatly affected.

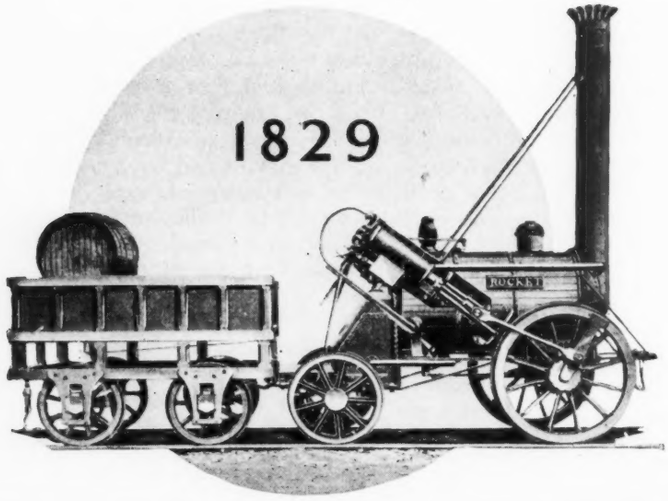
AS regards lubrication only, the poorest contact conditions would be those in which the contact lines between the worm threads and the gear teeth are arcs of circles, concentric with the worm, as shown in the lower portion of the accompanying figure. Here the lubricant would have but little chance of being renewed as the contact progressed from the bottom to the top of the worm threads. In addition, the worm thread would be subjected to local wear and would thus tend to lose its form.

As regards the specific compressive stresses set up in the materials by such line contact, the radial contact conditions shown in the figure would be much more favorable than the concentric contact conditions shown. With radial contact, the line contact would be along a profile with a relatively small radius of curvature, that is, the radius of curvature of the tooth profile, while the contact in a section perpendicular to the radial contact line would be a point contact between profiles having relatively large radii of curvature: these radii depending upon the thread angle and the lead angle, and often amounting to as much as sixteen or twenty times the average radius of curvature of the gear tooth profile. With concentric contact, on the other hand, the line contact would be along the larger radii of curvature, while the point contact would be between the smaller radii of curvature. On account of the larger radii of curvature for the point contact, with equal lengths of contact lines in both cases, a worm drive with radial contact would have a load carrying ability, as far as the compressive fatigues of the materials is involved, about sixteen times as great as a worm drive with concentric contact lines. The length of the radial contact lines, however, would only be about one-quarter of the length of the concentric contact lines. Considering this, the load carrying ability of the worm with radial contact lines would still be about four times as great as a drive with concentric contact lines, in addition to which, the drive with radial contact lines would have much more favorable conditions of lubrication. It may, therefore, be assumed that the radial lines are the most desirable, and they may be used as a basis of comparison.

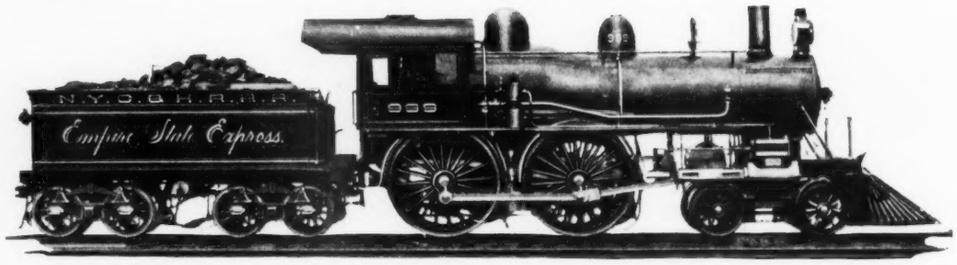
The conjugate action between the worm threads and the gear teeth will now be considered briefly. The circular pitch of the worm is uniform in the direction of the axis of the worm at any radius. Therefore, any part of the worm is suitable for a pitch surface. The circular pitch of the worm gear is constant only at some one specific diameter. That is, the circular pitch of the worm gear changes with the diameter, so that there is but one specific diameter where its circular pitch is identical to the axial pitch of the worm. The pitch surface of the worm gear, then is a cylinder, while the pitch surface of the worm is a plane tangent to the pitch cylinder of the worm gear and parallel to the axis of the worm. Conjugate action in worm drive takes place between sections of the worm thread profiles and the corresonding sections of the worm gear tooth profile as the advancing profiles of the worm thread sections are screwed through the sectional planes. A knowledge of conjugate action is necessary to appreciate this functioning of worm drives. The action is the same as for spur gearing; any section of the worm gear may be considered as the section of a spur gear, while any section of the worm thread may be considered as the section of the rack to which the gear tooth profile is conjugate.

THE foregoing introduction gives some idea of the complexity of the worm drive problem. A first step towards the solution of the problem is a study of the geometric properties of the warped surfaces of the worm threads, or their helicoidal sections. These surfaces are, in effect, warped cones. Such a study is necessary in order to establish the exact nature of the contact between the worm and gear, the effect of changing the size of the pitch, the differences between chased and milled worms, and the effect on the thread form as caused by differences in the diameter of the milling cutter or grinding wheel that may be used.

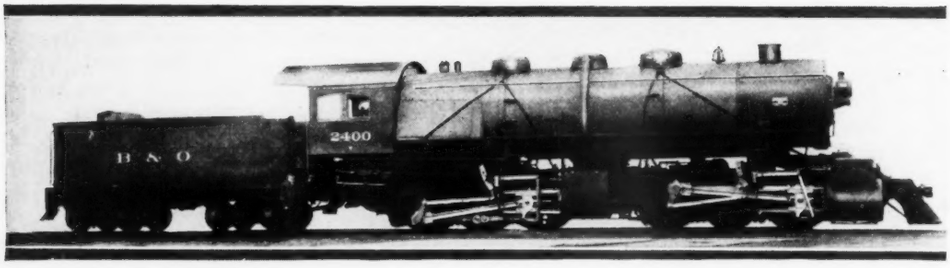
A HUNDRED YEARS of



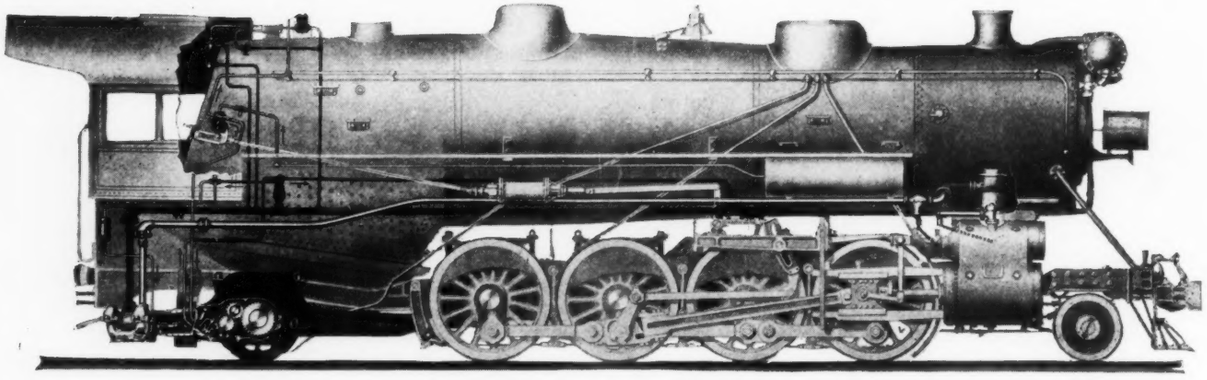
The "Rocket," the first really successful high speed locomotive, built in 1829. It had a multi-tubular boiler, used forced draft by exhaust steam, and had the piston rod and crank pin direct connected by a driving rod. Its free speed of 29½ m.p.h. convinced people that a new era of transportation was beginning its development



The famous 999 which in 1893 attained a speed of 112½ m.p.h. while pulling the Empire State Express of the New York Central Railroad on the run from Batavia to Buffalo. It had a 58 in. diameter boiler operating at 190 lb. per sq.in. pressure, and 86 in. diameter driving wheels. The engine alone weighed 124,000 lb. and exerted a pull of 16,300 pounds

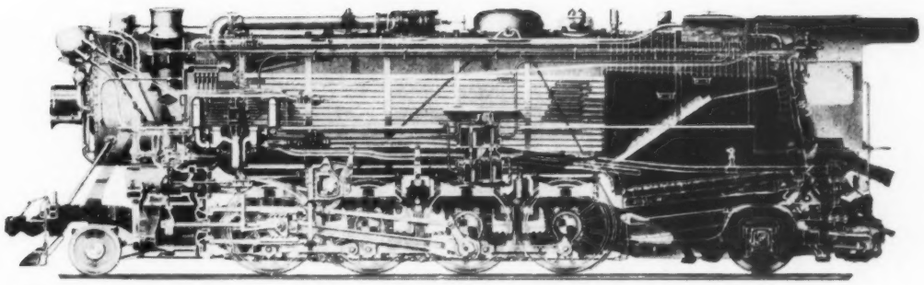


The Mallet type locomotive shown here, built in 1904, was one of the first in this country using the Walschaert valve gear. This valve gear weighed about one-half as much as the Stephenson Link, and, being located on the sides, was more accessible and permitted larger boilers and better bracing of the locomotive frame

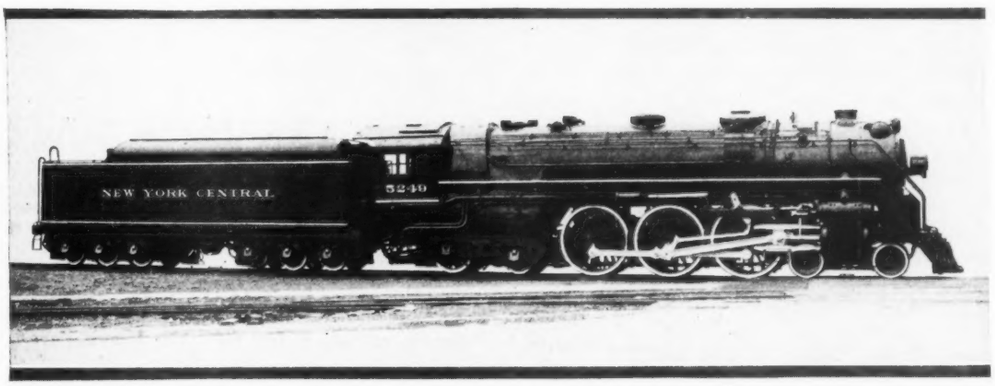


By 1920 locomotive boosters were coming into general use. The booster, located in the trailing truck, as shown above, or in the tender truck, increases the tractive effort at starting and cuts out automatically at 21 mi. per hour

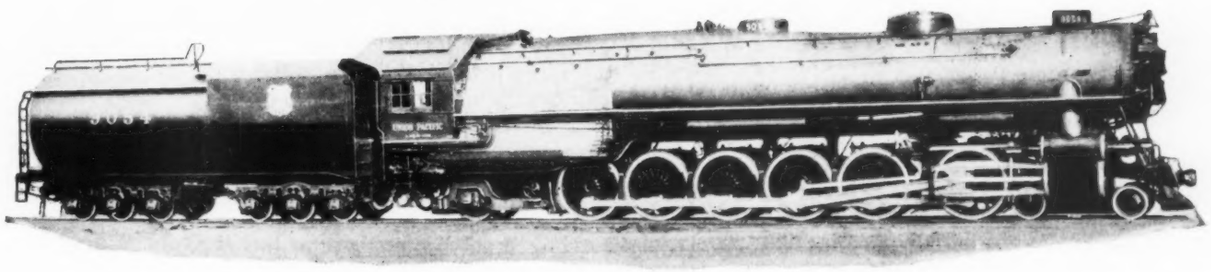
LOCOMOTIVE DESIGN



A locomotive of the year 1922. Mechanical stokers, feed water heaters, and steam superheaters, which, together with boiler pressures of 225 to 250 lb. per sq.in., all contributed to raising the overall thermal efficiency of the steam locomotive to about 6.3 per cent



The latest passenger locomotive of the New York Central, capable of pulling a train of 17 or 18 Pullman cars on the fastest schedules of the New York Central Railroad

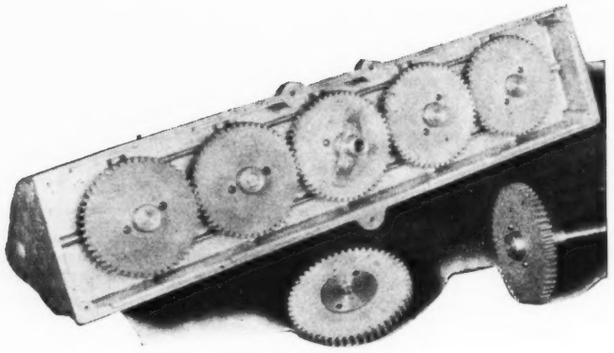


One of the latest 3-cylinder, high-speed freight locomotives of the Union Pacific. The largest and most powerful non-articulated engine ever built, capable of hauling at 50 m.p.h. trains a mile long

1930 The demand today is for passenger locomotives capable of pulling greater loads without sacrificing their present speed, and freight locomotives to handle heavier freight trains at greater speeds over increased mileage per day. How will the engineer meet this demand? Articles to appear in early issues will set forth what is being done in railroad locomotive design

Photographs by courtesy of the American Locomotive Company, The Lima Locomotive Works, Inc., and the Franklin Railway Supply Company.

LAMINATED MOLDED MATERIALS

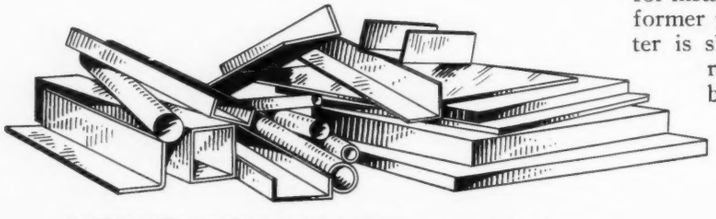


By GERALD H. MAINS

Technical Assistant to the Manager, Material and Process Engineering Department, Westinghouse Electric and Manufacturing Company

EMPLOYED until only recently largely as insulating materials, the resinoid molding compounds have within a comparatively short time jumped to a highly important place as economical raw materials for an increasing variety of mechanical and electrical parts. They are being used to replace hard rubber, wood, fiber, and metals, although they have their own peculiar properties and cannot be considered as direct substitutes. They must be accepted as new materials, which for some uses have distinct advantages, while for other uses they are substituted because of lower manufacturing or operating costs.

The resinoids are complex chemical products which have the property of being capable of being worked or applied in powder or liquid form, and then being set permanently under heat and pressure when the desired shape is attained. When once set they are hard, strong, moisture-proof, acid-resistant, and excellent electric insulators. In this condition the chemical combination has been completed, and they cannot be worked further, except by machining. They are thus ideal molding materials, and can be mixed with wood flour, mineral fillers, paper, or fabric, to give greater tensile strength, add to their machinability, or vary the physical properties in other ways. Research has developed numerous of these resinoids from a wide range of industrial chemicals, each group having peculiar properties of its own, the most important commercial differences, outside of price, being color, hardness, and resistance to temperature. By far the most widely used at the present time is the group of phenol-formaldehyde resins, because of the availability of the raw materials and the general suitability for mechanical and electrical parts. Because of its darker color, phenol resin cannot be dyed to the bright shades needed for certain novelties, but this is not considered a disadvantage for mechanical parts. The making of the resins themselves is a specialized chemical industry, and is not done by the molders, except where very large production warrants it.

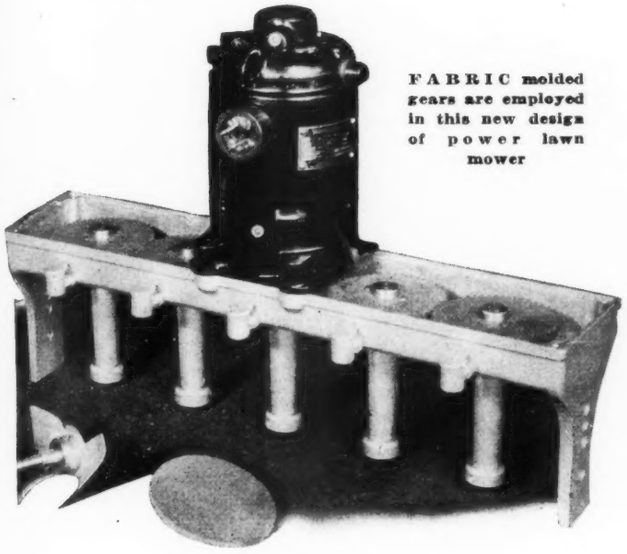


LAMINATED MOLDED PRODUCTS are available in many commercial forms

This article will deal only with the impregnated paper and fabric materials as distinct from products molded from the resins alone or mixed with a powdered filler. All of the illustrations and applications shown are those of the material known to the trade as Micarta. It is generally made with phenol resins, although not limited to these. In calling for parts to be molded as Micarta or cut up from Micarta sheet, the designer should keep in mind the several classes of the product, because of the differences in physical properties which vary, not so much in the resin, but in the impregnated material and the method of fabrication. For this reason an outline of the manufacturing process will be given.

Micarta is a laminated molded material made usually with a base of either paper or fabric. Some special heat-insulating Micarta materials are made with an asbestos base. The paper-base product is made with tough papers such as kraft or high grade absorbent papers as for instance those commercially known as rag stock. The former product has higher mechanical strength; the latter is slightly more expensive but has better moisture resisting and machining properties. The fabric-base product is made with either duck (heavy weave cotton) or with fine weave cotton fabrics. The duck-base product is characterized by great toughness, while the fine weave material is used for small parts requiring intricate machining.

The paper or fabric is impregnated by



FABRIC molded gears are employed in this new design of power lawn mower

Within a space of a few years chemical research has brought forward a new group of compounds that the designer can balance against wood, fiber, rubber, or even metals, in considering the choice of raw material for parts.

running it from rolls through a solution of the resin. Resin content is controlled by the dilution of the solution or by passing the material through squeezer rolls. The impregnated material is then passed through a horizontal or vertical oven, having a carefully regulated temperature in order to dry without setting. The large rolls of impregnated material are then cut up into sheets 36x36 in. or 48x96 in., ready for the presses.

Stock Micarta comes in sheets, rods, and tubes. The sheets or plates are made by pressing together and causing the impregnated sheets of paper or fabric to set. Any desired thickness can be obtained without special set-ups or expense for tools, by selecting the proper number of layers of the impregnated material. These layers, or laminations, are placed between steel plates and pressed in a hydraulic press under a pressure of 1,000 to 3,000 lb. per sq.in., and at a temperature of 300 to 350 deg. F. Sheets ranging from 0.008 in. to 10 in. thick are made. The color and finish of the resultant sheet depends upon the color and finish of the outside laminations. The usual commercial colors are natural (dark tan) and black. Green, red, and brown are also made. Wood finishes and special designs are obtained by having the design printed on the outside paper lamination before it is impregnated. The polish of the finished sheets is dependent largely upon the polish of the pressing plates which are of copper, steel or an alloy. These are polished lengthwise to mirror, semi-glass, or satin finish, depending on the surface desired on the pressed sheets.

STRIPS and gear blanks of the material are made by sawing up sheets in ordinary woodworking machinery, the impregnated material being easily machinable. However, special cutting speeds and sharpening of cutting tools must be used for best results. Thin sheets are punched or stamped out either cold or hot into washers and various shapes for mechanical and electrical applications. Lettering is done by embossing dies or by engraving. Channels and angles are made by cutting the impregnated material into strips and then forming in molds under hydraulic pressure. It is not possible to bend or form the material to any great extent after setting under heat and pressure, as this action forms a definite unpliable chemical compound of great stability. Brackets may be built up from channels and angles.

Tubes are produced in special machines, the operation consisting essentially in rolling the paper or fabric around a mandrel, at the same time pressing with heated rolls. It can thus be seen that almost any diameter of tube and any wall thickness can be had by simply changing the size of mandrel and rolls. The tubes are ground to commercial limits on a belt grinder. Where exceptionally close limits on the outside diameter are required, they are obtained by the use of centerless grinders. Rods are made likewise by rolling, although pressed rods are also produced.

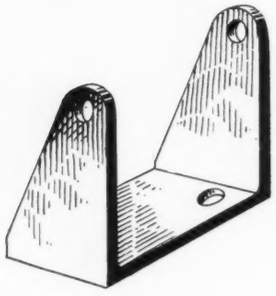
From a study of the method of manufacture, it is readily seen that the layers of base material are in definite positions with relation to the product, and it is best to take this into consideration in planning a part to be made.

GEAR MATERIAL is built up of a large number of impregnated laminations compressed and cured in a hydraulic press

Gears are so cut from Micarta plate or from molded gear blanks that the forces on the teeth will be against the edges of the fabric. Such things as trays or cup-shaped articles are cut out and formed approximately to the shape of the finished article before being hydraulically pressed. This gives the maximum tensile strength in all sections. Macerated material, that is, impregnated fabric, cut into small pieces and pressed together, is used for the molding of small articles of intricate shapes. For large parts of difficult shape, combinations of formed sheets and macerated material are employed.

The tensile strength of Micarta ranges from 7,000 to 20,000 lb. per sq.in., depending upon the grade, and its compressive strength is from 15,000 to 40,000 lb. per sq.in. normal to the laminations. Considering its low specific gravity, it is one of the strongest materials per unit of weight now available for structural applications. The Brinell hardness of the fabric material such as used

for silent gears is about 34. The material has a greater resistance to shock than cast iron. When the paper-base Micarta is molded into shapes such as blades, it has considerable elasticity, so that a bent blade will tend to spring back to its normal position. Because of the laminated structure, the designer should use some of the same precautions in designing parts of the material as when employing wood. Wherever possible, compressive stresses should be taken against the laminations, and holes should be drilled across instead of parallel to the layers, in order to prevent splitting of the material along the laminations.



THIS ACID-RESISTANT BRACKET of a chemical machine is cut from a molded channel section on ordinary woodworking machine

An outstanding use of the laminated phenolic products is in the making of silent gears. They have almost completely replaced fiber and rawhide for machinery gears and pinions, where there is apt to be contact with oil, moisture, or chemical laden atmospheres. Besides their non-absorbent qualities, Micarta gears have greater strength than those made of other materials. They can be made readily in all of the standard gear and worm shapes, and where added strength or wear resistance is desired, the material can be reenforced with riveted end plates, flanged metal hubs, or bushings. The automotive timing gear is the most extensive single application.

IN THE textile industry, where a high atmospheric humidity is maintained in the spinning and weaving rooms, laminated molded products are finding increased use to replace wooden and fiber parts of machines. The long wooden shuttle races of looms, which were apt to warp and stick, are now made successfully of strip Micarta. The shuttle races of narrow fabric looms are also replaced with this material, and give a greatly increased life under the severe strain of the high-speed movement, besides being non-warping. On the Crompton & Knowles tape loom the shuttle runs are made from Micarta plate. In the tenter-frames made by the Textile Finishing Machinery Company, and the James Hunter Machine Company, Micarta jaw openers are used to replace the bronze jaws formerly used. These jaws hold the cloth in stretching, and must maintain a perfectly smooth working surface. In textile dying and finishing machines molded rolls are used effectively, and give long life, unaffected by the heat and chemicals employed in the machine.

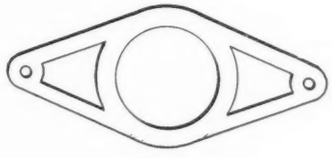
Likewise in the rayon industry Micarta is being used with success. It has proven an ideal material for numerous parts such as spinning brackets, because of its high mechanical strength and excellent acid and moisture resisting qualities.

Airplane pulleys are typical examples of outstanding advantages of molded laminated materials. They are strong enough to take care of any load that may be placed upon them, are extremely wear resistant, have only about half the weight of the light metal alloys and will withstand continued exposure to the atmosphere. Other airplane parts, such as the hinge bearings, are likewise made of this molded material. For many of the pulleys the macerated fabric material is used, and self-lubricating graphitic bearing centers are molded in.

Another field in which Micarta is proving a success is in the paper industry. Here it is being used as doctor blades or scrapers on the wet side of the paper machines. It wears well in contact with the steel, brass, and rubber rolls which are commonly used, and does not have a tendency to chip, crack, or warp.

For chemical machinery laminated molded materials have a wide range of application for linings, brackets, drip cups, parts exposed to dilute acid or alkali solutions, pump washers, and tube connections. Standard commercial tools, rods, plates, channels and angles in black or tan colors are generally called for by the machine designer to be cut up to the desired shapes in the same manner as metal. Small washers are made of the fine cotton-base material or of the paper-base, while large rings are usually best made of the strong duck.

IN ELECTRICAL machinery, instruments, and radio, laminated molded materials are used for insulating plates, cleats, washers, bushings, and spacers; and for panels, pull rods, meter box covers, barrier plates, switch plates, pulleys, gears, and brackets. For portable instrument boxes, where the trade calls for a true mahogany or hardwood finish, a sheet of the true wood veneer is coated with the phenol varnish, and used as the outside lamination in the molding process. It retains the appearance of the original polished wood, and has the added feature of resistance to moisture and acid. A novel em-



THE LOUD-SPEAKER DIAPHRAM SPRING at the left is made of paper-base molded Micarta by ordinary blanking tools

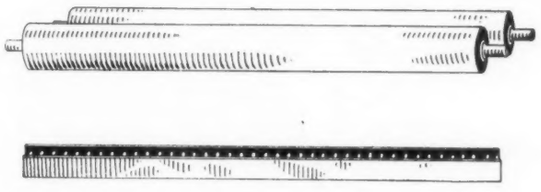
JAW OPENERS on a textile stretching machine are molded of phenolic resins, and are more wear-resistant against the cloth than the metal openers previously employed

AIRPLANE PULLEYS molded of macerated impregnated fabric. They have self-lubricating graphite centers molded in

ployment of this material of many uses is for the diaphragms of gas masks. For this purpose a thin fabric-base material is used. It permits passage of the sound waves of the voice, but resists entrance of any chemicals.

In considering the application of resinoid molded materials, the designer should bear in mind the great variety of forms and finishes in which this material is procurable. Of course, by resorting to special dies, an endless number of shapes and finishes may be obtained. Special die formed articles should be called for only when the number of pieces to be used is sufficiently great to offset the die cost. If only a relatively small number of the same parts are required, the designer may specify them to be machined out of board stock or some one of the many standard forms in which this material may be purchased. The design, in such cases, must be made so that the article may be manufactured economically from one of the standard shapes and sizes available.

It is always best for the designer to consult the vendors of molded phenolic compounds in order to ascertain the shapes and sizes in which the material may be obtained. In many cases, an otherwise unimportant change in the design of a part or article will permit the use of resinoid



SHUTTLE RUNS AND FINISHING ROLLS on textile machines are molded of laminated phenolic resin

molded material without involving any die charges, or at least, greatly reduce the die charges involved.

Modern tastes require color and decorative effects in the finishes of articles, be they lipstickholders or locomotives. As stated above, phenolic molded materials are available in a variety of colors and surface finishes. Artistic designs and lettering may be pressed into the surface of articles made of this resinoid material.

The field of usefulness of the phenolic molding compounds now reaches to almost every class of machine or instrument, and in almost all such design problems the engineer must consider them among his primary raw materials commercially available.

■

Beryllium for Aircraft

BERYLLIUM possesses valuable properties which make it ideal for use in aircraft construction. The metal has a specific gravity or weight of about two-thirds that of aluminum and less than twice that of water. It has strength and a modulus of elasticity comparable with that of steel, about the same coefficient of expansion and the same melting point as cast iron, and greater resistance to corrosion than aluminum. One important property it lacks, however, is ductility, since it is too brittle for many uses. Eight ductile alloys of beryllium and aluminum, containing a high percentage of beryllium, are reported to have a tensile strength of 80,000 lb. per sq.in. or even higher, and have a density nearer that of magnesium than that of aluminum.

The Seat of the Trouble

By Paul B. Swinton

GOING up to Boston one day I fell into conversation with the only other occupant of the smoking compartment. I don't know how we got on the subject, but at any rate he told me of an experience that proved conclusively that the cause of trouble is not always where the trouble is. This was the story as he told it.

"One of the leading manufacturers of textile machinery had spent two years, a pile of money, and a considerable amount of sweat and swearing, in developing what he hoped would be the last word in the design of weaving looms. When he at last arrived at the point where he considered the design perfected, he announced that he was prepared to furnish cotton looms that were about fifteen per cent speedier and twenty per cent more efficient than any that had ever been produced before, and the price would be twenty-five per cent less, to boot.

"In due time the factory received an order for a goodly quantity of the new machines. No human babies were ever more carefully nursed than were the machines on that first order. Finally, just to make absolutely certain, all the machines were given actual operating tests.

"The looms were eventually sent to the cotton mill and set up for operation. Then the fun began. The looms would not operate. Somehow or other, the shuttles simply would not keep going. The weaving room foreman even claimed that the new looms made the old ones work poorly, to be sure, he was right but did not know it.

"Well, the factory got a big howl from the mill in the shape of a telegram, and immediately sent about a half dozen of their engineers to investigate.

"Arrived at the mill, the factory engineers plus about as many more of the mill people had a practical demonstration of how a loom should not work. Then followed a lot of frowning and head shaking, trying to figure out why a perfectly good loom should act that way. While all this was going on, one of the young engineers from the loom factory sidled away from the crowd, took a stroll the length of the room, observed the motor at the far end, and the long slim line shaft running the length of the room and extended to accommodate the new looms. On returning, he addressed the assemblage. He told them that the long line shaft, driven from one end, twisted as the load came on and then untwisted as the load went off, thus making the shaft act like a spring and causing the machines to speed up and slow down erratically. And this resulted in the shuttles not being thrown at the proper speed or at the same speed at all times. He advised the mill people to use bigger shafting or to relocate the motor so as to drive the shaft at the middle instead of from one end.

"After a lot of argument, the mill people relocated the motor as suggested, and everything went smoothly, the new looms doing everything that was claimed for them."

"Then that was really all the cause of the trouble?" I asked, rather surprised.

"Yes, indeed, that was all there was to it. You see," he concluded, after a pause, and with a twinkle in his eye, "the seat of the trouble is not always where it sits."

"And what, may I ask, was your rôle?"

"Me?" asked my interesting conversationalist, "Oh, I was the fellow who designed the loom; the fellow who solved the problem was just a cub engineer who is now chief engineer of the same company."

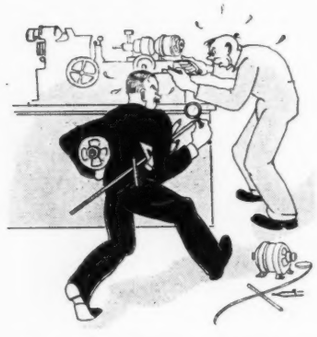
THE ENGINEERING

The scene is a big contract production shop, consolidated also with an iron foundry and a nonferrous metal plant. It controls, also, a smaller shop that makes a specialty of contract production for the chain stores and mail-order houses. Conferences of the engineering and affected production executives with the chief engineer have grown into what the plant calls "The Engineering Council," which meets in a "council room" in the engineering department. Foremen are called in, and others drop

Getting Action on Standards

"AS EVERYBODY in this company knows," began Chief Engineer Arthur Levering, in opening the weekly confab that the boss calls the Engineering Council, "I'm strong for cutting the cost of our products in any way we can, as long as the quality is kept up to par. Has anybody got any good ideas?"

"I have," responded the super, George Overman, with a grin on his broad countenance. "Usually I'm the goat when it comes to cost cutting, but this time it's up to the engineering and purchasing. What I want to see cut out is a lot of these units and fittings that mean special machine work. Take motor mounting brackets and flanges, for example. Every time a customer insists upon his own pet make of motor something has to be altered to suit it. Why, even a.c. and d.c. motors of the same make and power are not interchangeable! It's costing us a lot of money for this special work without giving the customer a nickel more in real value. Now why can't Art and Paul get their heads together, decide on some standard motor dimensions, and make the motor manufacturers stick to 'em?"



"That sounds logical and not so very difficult, George, but we're up against a stone wall," answered Art. "If we don't give options on the make of motor, customers are peeved, and naturally the sales department kicks. If we adopt 'standard' mounting dimensions of our own, we are lucky to get any motor builder to meet 'em without an extra charge for 'special' work, for we can't make a 'standard' that'll suit more than one or two makes. It's a ridiculous situation, but to date nobody's found a way out so far as motors for machine drives are concerned. Unit makers in every field constantly urge us to meet their own individual 'standards,' and we do so whenever it's feasible. But when we must maintain at least two sources of supply and the unit makers themselves don't agree, how can we settle the argument?"

"Looks to me as if some standardizing organization has missed a good bet here," injected Howard Hedley, the G.M. "I've heard various angles of the same topic discussed for twenty years, and still we lack strictly interchangeable motors. It's outrageous! If motor manufacturers don't agree on standard mounting dimensions before long, what's to hinder machine manufacturers from adopting some of their own?"

"Well," replied Art, "just about such a procedure has been followed in the automotive field, with great benefit. At first, some parts makers, when invited to co-operate refused to do so, but today the benefits on both sides are so well recognized that everybody agrees. What's more, it seldom takes more than a year or two to formulate a standard acceptable to everybody. It certainly would help, Howard, if you'd start such a movement among machine builders."

Here is a plant force that is aggravated by lack of facilities for changing from one type of motor to another. Is it an exaggerated case, or would standards help the industry? Publishable answers from designers will be paid for.

COUNCIL

in. The problems are not solved for the readers, but some of the opposing opinions are brought out. Engineers and designers are invited to discuss the problem, or to present new problems for discussion. Acceptable letters are paid for at regular rates.

DISCUSSION
OF COUNCIL TOPICS

When Sales Take a Slump

DESIGNERS can best keep in active contact with customer's requirements by putting themselves in the customer's place. In that way only can they anticipate his wants. Their individual preferences will be abandoned, and they will attempt to fulfill the customer's requirements.

Contemporary literature and advertisements of the trade may be studied to advantage. Products similar in design or with similar characteristics may furnish ideas. Also, associates or practical men may be able to give valuable assistance. If information from these varied sources is combined, a proper amount of time allowed for a thorough job, and full attention given to the work in hand, the result will be what is wanted in almost every case.

Experiment is one of the chief constituents of progress. It is not enough to keep posted on what competitors are doing. That makes the designer a follower, not a leader. He must keep posted on the latest developments of research, science, and invention that affect, either directly or indirectly, his product, and must be resolute and prompt in their application.

—J. J. WOFFINGTON,
Lillington, England.

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Developing New Products

IT IS now well recognized that no productive concern can "stand pat" on its current designs for any great length of time. It is a case of progress or ultimate failure.

Outstanding companies in automotive, domestic appliance, machinery, and other fields have reached and are holding leadership as a result of the most thorough, scientific research and development work. They have found that such methods pay a very high return on the money thus invested, and have concluded that their business is unsafe if conducted on any other basis. Smaller concerns face financial and other limitations but the same necessity of progress exists.

A large organization is justified in having a development engineer with assistants, laboratory and experimental shop facilities; whereas, a small company finds it more expedient to combine the work of development with drafting, designing or engineering. This has its drawbacks but is far better than failure to keep a few steps ahead of competition or to suffer from "dry rot."

A development department should see that its personnel:

1. Reads and makes available for future reference all pertinent literature in books, trade magazines and advertising matter.

2. Collects and files catalogs, pamphlets, "house organs" and other publications of competitors.

3. Tests, analyzes or by any fair means determines the general characteristics, performance, strong and weak points of competing machines or products as well as those of its own manufacture, records the results and tabulates same comparatively wherever possible.

4. Makes records of all troubles and criticisms of products or machines in actual service, and encourage suggestions for improvements in its own products from employees, customers and all other possible sources.

5. Reviews each issue of Patent Office Gazette and copies of pertinent new patents under which competing products or machines are manufactured.

Redesign or improvement of the products of such a company then can be accomplished with the utmost intelligence, and usually will make it possible to "get the jump" on competitors. Competing products must be outclassed if a commanding position is to be attained. The results of comparative tests when discretely used often are of great assistance to the sales department and add greatly to the information and enthusiasm of the sales force.

In development work every line of investigation will not lead to results worthy of adoption. Failures, however, often add much to the knowledge of the subject and successful efforts furnish full justification for the entire program. It is much better, of course, to have failures occur during experimental tests than to proceed blindly and impose faulty machines or products upon customers, with heavy losses of money and good will. A real live concern will leave nothing to chance.

—F. C. BLANCHARD, *Chief Engineer, Rivett Lathe & Grinder Corporation.*

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Do You Still "Roll Your Own?"

OUR problem in the aircraft industry is perhaps a bit more difficult than that confronting designers of more standardized mechanical products. We cannot buy 5,000 of this eye-bolt or that spring, even though these items may be purchased at less than half the cost of those of our own manufacture; for often, before even a small part of such a quantity is used, the assembly on which it is installed, or even the entire plane itself, may be declared obsolete so far as further production is concerned.

The distinctive appearance of an airplane depends upon the painstaking design of each and every small part that goes into it. The designer is, therefore, reluctant to "give in" and see a carefully designed special part replaced by a commercial item which is almost, but not quite, the thing he has in mind.

Let us suppose that, for an experimental project, 25 fittings of a certain kind are required. A draftsman draws up the fitting exactly as required, then submits it to the chief draftsman or chief engineer for approval before work is started. The chief engineer remembers having seen something almost like it in a catalog and calls the purchasing department for information. He is told that the substitute may be obtained in some city about a thousand miles from the plant, and can be delivered in eight to ten days. Time being a most important element in this industry, the chances are that the original drawings will be approved and sent into the shop. The finished fittings will go into the plane at a cost many times greater, but a few days earlier, than the purchased part would have gone. However, the part used is the one actually required, and not one almost like it.

—G. C. MCKINNEY,
Chief Draftsman, Watkins Aircraft Co.

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When Sales Take a Slump

CONSUMER'S requirements are usually gaged by the newest product on the market. Therefore designers can best anticipate what will be required by keeping in contact with the developments in the products of competitors, and gage required developments by this standard.

Further, manufacturers cannot expect an article to remain a criterion after newer and better products have been produced. A good indication of the sales power of an article is the selling cost. Increases in sales costs at times of a favorable economic situation are an unmistakable danger signal. The salesman, the "man at the front," must hear this danger signal and pass it back to the plant manager. This means that it will be communicated directly to the designer, and the designer must be ready with suggestions for improvement or changes in design. —ING. FRANZ BERMAN, *Supt., Staats Eisenbahn Gesellschaft, Vienna.*

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Developing New Products

PRODUCING a new product is a problem for the chief engineer. He has a man on his staff capable of analyzing and supervising this job, usually known as a development engineer. This engineer is assigned the development projects. A form is given him describing, in brief outline, the machine to be produced and stating the estimated time for completion. Detail spaces allow for the insertion of time required for engineering, time for making the prints, for assembling, and for testing the machine.

The development engineer proceeds with the work, and reports his progress weekly on his copy of the form. This form is handed to the chief engineer who forwards it to the general manager. It is then returned to the development engineer. All hold-ups on the job are also reported so that the chief engineer and the general manager get a picture of the progress of the work. The development engineer does not have jurisdiction over any draftsman or mechanic except those assigned to him. He calls upon the chief draftsman to assign one man or more to him as he requires, and does the same with workmen in the factory departments. As drawings, blueprints, or sketches, if they are to be used, are ready, they are issued to the factory department foreman, and the men assigned to the development engineer are put on that work. Thus, the foreman still retains full jurisdiction in the shop, but the development engineer has the right to give instructions and assistance to them.

—HAROLD LAMB, *Master Mechanic, Hookless Fastener Company.*

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Who Should Design Patterns?

THE answer depends on the size of the factory. In a small plant, where the pattern shop and foundry are managed by one foreman, the patternmakers should design patterns to the foreman's instructions; and it follows that the foreman should be capable of giving these instructions. All designs of castings should be submitted to him for criticism before being decided on definitely. In a larger plant the foundry superintendent will require at least one assistant whose main duty is to maintain contact between design, patternmaking, and molding departments, and who is free at any time for consultation by draftsmen during the working out of a design. In one plant employing a large staff of designers, but having no foundry of its own, the most satisfactory arrangement provides for all complicated castings to be designed by two draftsmen who keep in close contact with the head patternmaker.

When small numbers of large or complicated castings are required it is better to err on the side of excess weight than to risk making much scrap. But if any considerable quantity of parts is required, experimental work always should precede production and the cheapest design should be adopted. Taking into account such diverse factors as machinability and balance of moving parts, a light casting in an expensive iron with a large proportion of scrap in the foundry may be cheaper than a heavier one in a cheaper iron with a minimum of scrap or vice versa. The foundry superintendent, or his assistant, should oversee this experimental work.

—H. JAMES.

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Do You Still "Roll Your Own?"

THE problem stated is not one that can be solved by giving an order to "buy specialized products from specialists" because the specialists have not yet fully standardized their products.

The engineering societies have many committees working with the specialists getting competitors together to decide upon standard dimensions. This is a slow process because many of the specialists established their own "standards" and find it difficult to change their products to conform with the recommendations of Standards Committees. Well-equipped engineering department libraries contain copies of the reports of these committees, as well as the catalogs of manufacturers.

Engineers and designers should use standard parts wherever possible, not only because the specialist can supply good parts at a low cost, but also so that their customers may be able to buy standard parts for repairs. For this last reason, a standard design should be used if possible, even though the parts are to be made at home, and not purchased from parts manufacturers.

In many instances, the design of a product that has been manufactured for some time can be changed slightly to allow the use of standard parts. Engineers, as a rule, make such changes when they find standard parts that fulfill their requirements. When designs cannot be changed, it is often profitable to have parts that are nearly the same as standard made by the specialists. If the quantities are large enough, the parts may sometimes be purchased at standard prices. —M. H. FLYNN, *Allen Manufacturing Company.*

Who Should Design Patterns?

TWO men designing a pattern with the necessary coreboxes for the same casting will, in a majority of instances, adopt the same procedure, but one will no doubt incorporate some apparently insignificant point that will make a great difference when the piece is cast. These two men, who have learned their trades at different shops, perhaps, will have quite a different slant on the same job. What must the difference be when one has never learned the trade, as is the case with 99 per cent of the designers of today? Designers have a general knowledge of patternmaking and molding, but expecting them to have a fundamental knowledge of both trades as well as their own art is asking too much. A designer, as it is, must know foundry practice, machine shop practice, erection, production, costs, materials, and often a certain amount of electricity.

The best procedure is to send a semi-final scheme of a projected machine to all departments concerned, noting their comments as they check the design. These notes will enable the designer to produce a final design which will be satisfactory to all parties, and also will enable him to keep up-to-date in his knowledge of methods and manners in the production departments, thus keeping down manufacturing costs.

A designer can best make the most of his job by sticking to it. A casting can be well cast if it has been well designed, for the patternmaker can usually make the pattern and coreboxes for such a job.

—JAMES R. CORNELIUS, *Designer, Coventry, England.*

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When Sales Take a Slump

DESIGNERS will have little trouble keeping in contact with consumers' wants if they will but show a disposition to co-operate with salesmen. The salesman is always in direct contact with consumers and is in a better position to learn consumers' wants than anyone else. From him the designer can learn just what the consumer thinks of his work and can keep informed of anything new which competitors are putting out and how it is "going over."

The designer of a household commodity such as a burner should know his product is seldom given adequate attention. He should make his designs accordingly. The average man expects any household commodity to run without any trouble. If he has to be constantly tinkering with it or calling the service men, he considers it a nuisance no matter how good it may be. If the burner happens to make a lot of noise he doesn't want it, even though it is superior to any other burner on the market. The first thing to consider in designing any household commodity is simplicity. —W. J. OWENS, *Foreman, Newport Rolling Mill Company.*

HIGH-STRENGTH CAST IRON

As a Construction Material

ADDITION of 1¼ per cent of nickel gives these cast gears hardness for long wear together with toughness and strength for resisting heavy-duty operating stresses

By J. S. VANICK

Metallurgist
International Nickel Company

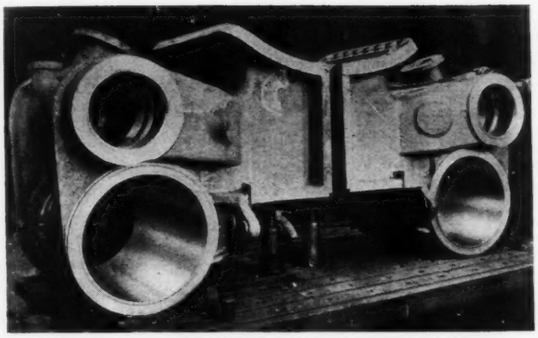
BESIDES its low cost, cast iron has several important advantages as a machinery construction material. It can be cast readily into intricate shapes, is wear resistant, durable, easily machined, and has a crystalline and graphitic structure well suited for sliding surfaces or bearings. But ordinary cast iron has low tensile strength, usually figured at about 22,000 lb. per sq.in., and if carelessly run in the foundry or made up with miscellaneous scrap iron, is likely to have pits or blow holes. Much of the investigation work on cast iron during the past few years has had the object of producing with facility an iron having greater tensile strength and a dependable uniformity of structure and freedom from imperfections. The new, high-strength cast irons, made with nickel additions, have tensile strengths sometimes more than double those of ordinary gray iron. With improvements in foundry methods, they can be produced with uniform structures. The immediate results are twofold—equal strength can now be obtained in parts with much lighter sections; and much higher pressures or stresses can be used with the same sections. Moreover, because of the assurance of uniformity of structure, the necessary factor of safety in design calculations can be greatly reduced.

The question at once arises as to the possibility of the designer calling for these high-test irons from the regular foundry organization of his plant or from the ordinary jobbing foundry. It is the purpose of this article to give the background of the requirements and characteristics in the high-test nickel irons in order to indicate the possibilities.

Carbon and silicon are important elements affecting the strength and structure of ordinary cast iron, but thousands of tests by experimenters have definitely established the limits of strength obtained by these elements. With proper melting and pouring conditions, it is possible to obtain a tensile strength of 35,000 to 40,000 lb. per sq.in. By casting a white iron and then heat-treating, which is a malleablizing treatment, it is possible to produce somewhat higher strengths, but such treatments are generally costly because of the time involved and the possibility of warpage and cracking of the castings.

High-strength cast iron alloyed with nicked has a fine-grained, uniform, dense structure, and will retain this uniformity even in castings of uneven section. The effect of nickel is to refine the grain of the iron. It is most effective in small amounts, from 0.75 to 2.0 per cent. It assists graphite formation and thus acts to reduce chill and to eliminate hard spots and mottled areas. In this respect it acts like silicon, but the effect of the nickel is progressive, and it does not impair the physical properties as does silicon. Nickel also increases the hardness of the iron, but at the same time it improves the machinability because of the elimination of chilled areas and hard carbide spots that dull the tool. Nickel increases the strength of cast iron, and this strength, with simple additions of 1.0 to 3 per cent of nickel, is well in excess of 40,000 lb. It has been found that if the temperature of molten iron is reasonably high, as much as 5 per cent of nickel will dissolve completely and uniformly in the ladle. It can thus be seen that, from the designer's standpoint, it does not place any hardship on the foundry in calling for iron of this class.

The first step in obtaining an economical, high-test cast iron is to keep the carbon content low, from 2.50 to 3.10 per cent, and in the iron as fine, evenly distributed



NICKEL-CAST-IRON CYLINDERS
weighing 10,000 lb. each.. Sections are 1¼ to 2¾ inches

graphite. The silicon can vary from 1.25 to 3 per cent, depending upon the hardness and wear-resistant properties desired. The carbon control is effected in the foundry by using a percentage of selected steel scrap, by deoxidizing with ferro-manganese, and by control of the temperature. The second step is by the addition of alloying metals, nickel, and sometimes chromium. Nickel can be charged in the cupola, or it can be added in the ladle. The latter method is, in fact, preferable, as it does not disturb other elements in the melt.

Nickel cast irons made in this manner have a tensile strength ranging up to 65,000 lb. per sq.in. They are known as high-strength, nickel cast irons. Where it is necessary to make a compromise with current foundry practice, chromium is also added to the regular mix to offset some of the undesirable properties of the iron and thus obtain a modified, high-strength iron with a tensile strength between 35,000 and 45,000 lb. per sq. inch.

The effect of chromium on iron is to refine the grain and to increase its chilling power. By the use of chromium the combined carbon in the iron can be raised. In using the nickel and chromium, the nickel restrains the chilling action of the chromium. This metal is added in the foundry in the same manner as nickel, or in the form of ferro-chromium alloys. The action of nickel alone in increasing strength is dependent upon the presence of a reasonable amount of combined carbon, preferably up to 0.80 per cent, and this is admirably controlled with the aid of the chromium.

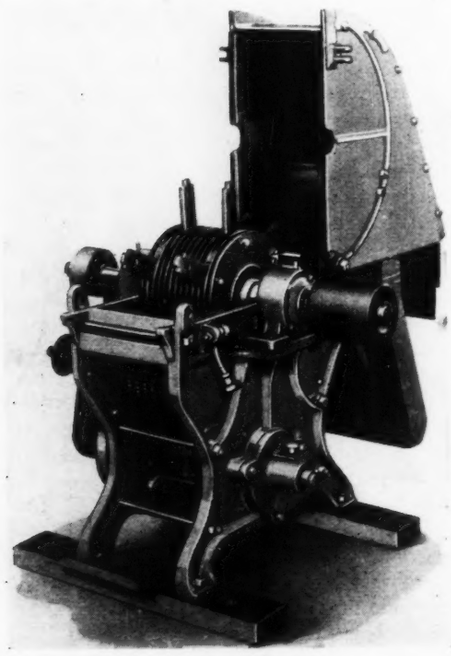
High-strength cast iron, containing nickel or nickel-chromium, can be employed effectively for a wide range of parts in all kinds of machinery to replace ordinary gray iron, malleable iron, or, in some cases, in preference to steel. Where any great degree of elasticity is required, it is not recommended, but where rigidity and good wearing qualities are wanted, it is admirably suited. For castings in which pressure tightness is desired, such as in pump bodies, this class of iron is valuable because of its fine, close grain, and its freedom from porosity. High-strength irons, with 1 to 3 per cent of nickel and with chromium in the 3 to 1 ratio, are used for gears and pinions in which a combination of strength, toughness, and good wearing qualities is desired.

Other uses of nickel cast irons are for: Machine brackets, machine frames, arms and small parts, Diesel and locomotive pistons, valves, rolls and driving-gears, sheave wheels, and brake drums. Because of its increased hardness and improved wearing properties, nickel cast iron is used in the large engine and compressor field for cylinders and cylinder sleeves as well as for machine bushings and cams. For passenger car and truck engines, the nickel-chromium types of cast irons are in general use.

REDESIGN FOR WELDED CONSTRUCTION

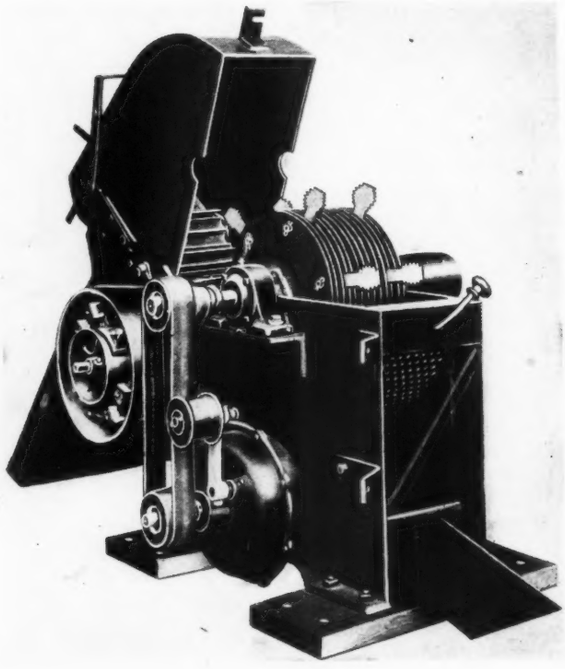
BY C. M. TAYLOR
Vice-president, Lincoln Electric Company

REDESIGNING the cast-iron feed mill built by A. M. Dellinger, Lancaster, Pa., resulted in increased strength and rigidity, greater capacity, improved appearance, and longer life. Manufacturing costs were also reduced.



The original feed mill of cast construction is pictured at the left. All parts substituted in the redesign were steel sections

Brackets, main frame, cover, chute, sieves, braces, minor mill parts, and balance rotors are arc welded in the new model at the right



"THE day has passed when the man known as the designer or artist will be merely tolerated in the manufacturing plant. The art appeal has arrived as the strongest appeal in modern business. It is for the manufacturer to measure this new demand on the part of his customer. He must spare no pains and no expense in getting the best designs from the most skilled designers."
RALPH ABERCROMBIE,
Annual Convention, A.M.A., 1929

ORNAMENTAL metal containers are made of brass alloys in hundreds of shapes, sizes, and finishes

APPLIED ART in METAL PRODUCTS

By COLIN BARRETT
Art Director, Scovill Manufacturing Company

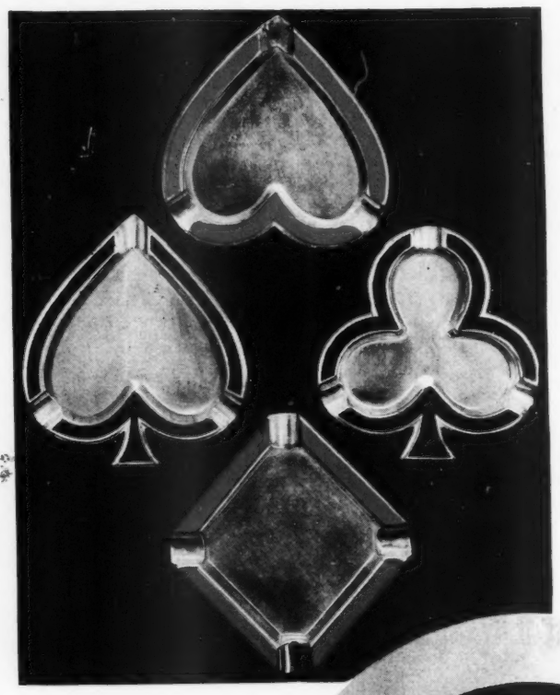
THERE are two reasons for the application of art to utilitarian metal products. The first of these is the direct art appeal in sales, the product appealing in this way to the eye of the prospective buyer, maintaining its competitive sales value primarily by its artistry. In such cases, the art element is held within bounds, measured by the price of competitive products. In the second case, art is incorporated in the product as a permanent asset for its aesthetic effect as an addition to the utilitarian value of the article; and here greater rein is given the designer, carrying with it much freedom to call for changes in the material or form of the product. The artist's specifications may reach back to affect the raw material as well as the processes in the fabrication and finishing operations. The designer thus aims to produce in the finished product a work that is a piece of art in addition to its utilitarian qualities, even to a greater degree than might appear to be necessary for its ready sale. Usually, considerable extra expense in design and production is involved in obtaining an artistic utilitarian product, but the buyer of "quality" goods generally accepts the added cost price with full knowledge of the lower price of the merely utilitarian product. In other words the artistically designed article is considered as having a worth apart from its utilitarian value.

Although art in metal products is beginning to receive more attention than ever before, it is not an entirely new thing in this country. Machines built from 50 to 100 years ago were frequently designed with ornamental and curved legs and with scroll work that was purely ornamental in effect. A century ago the Yankee novelty makers of New England were producing ornamental products in metal. In 1824 when the Marquis de Lafayette visited America the Scovill Manufacturing Company of Waterbury, Conn., presented him with a set of ornamental buttons made of solid gold bearing his profile struck by hand-cut embossing dies. After the 80's, however, the machinery builders dropped almost completely the ornamentation of their product, and it has been only since the war that much attention has been given to grace and beauty in machine lines, and bright colored finishes.

PASSING to an object essentially more decorative in character, we see in the evolution of vanity case design an impressive demonstration of the trend toward delicacy of structure, grace of form, and harmonious variety of color. Brass producers issued cases, at first, of substantial dimensions, severely round or square in form, and of plain metal finish. In only the course of a few years—less than half a dozen—there developed the styles of case which make the manufacturer's exhibit today vie in brilliance and subtlety with the products of the jeweler. The development of novel and artistic forms has been a natural one from the simple and sizeable round box through successive stages of smaller and more delicate design; first to a variety of special shaped containers, and then to a very general use of colors; and the progress has been one of trend toward standards set by exclusive

handwork. Both in form characteristics and design, the art control and the manufacturing process have succeeded in bringing to large quantity production a quality standard hardly dreamed of a few years ago.

This story will deal chiefly with some classes of product in which the art treatment stands out as a major consideration: that is, articles that have in themselves become art products as distinct from intrinsically complete articles to which artistic elements have been added, such as the automobile. Such metal products include: buttons, buckles, compact cases, ash trays, lighters, lamps, electrical house fixtures, automobile hardware, stoves, and a vast array of other articles for many purposes.



SILVER PLATED, enameled ash-tray sets are among the innumerable pressed-metal novelties on which the art metal designer can use his imagination. The cost of this product is more in the art work and finishing than in the metal stamping

THE variety of metal products of this class, and the necessity for following the ever-changing styles and designs, make this branch of metal product manufacturing, from the design and production standpoint, as complex as the problem presented in the textile industry by the changing styles. The Scovill Manufacturing Company, as an example of a large manufacturer of art products, may have as many as 1,500 different products, exclusive of parts, in the process of production at one time, and as a considerable number of these embody the aesthetic principle, the company employs a staff of artists in addition to its designers.

TYPICAL art work on an automobile hub cap for a wire wheel

THIS HUB CAP presents a shop production problem, but the appearance warrants the expense

It must always be borne in mind that a factor of prime importance in such work is the requirement of large scale production. Craftsmanship in the old manual sense is not and cannot be implied in modern quantity production. The attainment of an aesthetic standard is, thus, a new and specific problem, to be handled by the personnel of production organization and production control.

The production problems involved in the manufacturing of art products must, therefore, be taken into consideration by the designer and artist, since the manufacturing departments cannot be called upon blindly to produce a given form or finish unless all factors have been considered. In order to obtain certain results to the best advantage in the finish it may be necessary to call for the help of the metallurgists and maintain a definite control from the raw metal stage onward. The shop may find itself unable to make a specified form without excessive expense, while a slight change would simplify production greatly. The Scovill Manufacturing Company uses about 150 different alloys in the manufacture of its various products, about one-third of which represent ordinary production alloys, and about a dozen are used frequently in large quantities. When it is realized that colors and finishes with their

limitations must be permutated with a great number of different designs, some idea of the complex manufacturing problem involved may be seen.

That a product which does not present an artistic touch is at a marked disadvantage in the present-day competitive field is strikingly shown in the arctic and overshoe trade, where the addition of purely adventitious ornamental and colored metal buckles has had a marked effect on sales appeal. It is well exemplified too, in the automotive field where appearance has been a decided factor in sales. From among the various automobile parts where art has been applied in a practical way the hub cap may well be taken as an illustration.

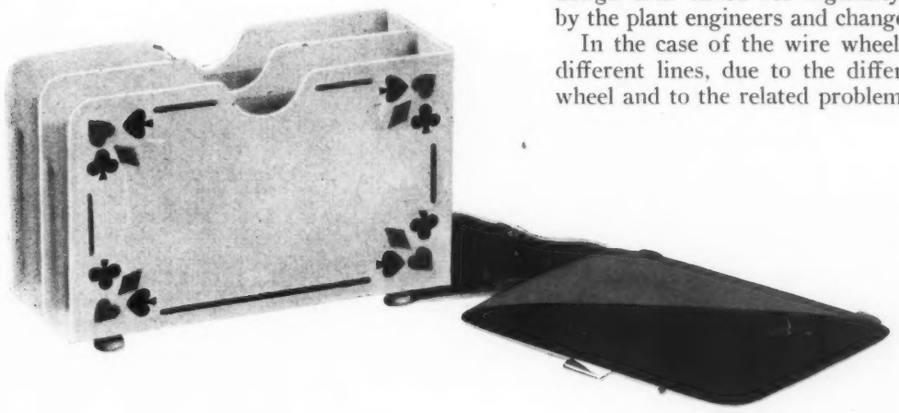
From the pure utility point of view, the hub cap was developed for a single function: to cover the axis of the hub of the wheel and thus keep the lubricant in and the dirt out. A cap or plate would do this, and if the journal or the locking nut protruded beyond the wheel, then the plate or cap had to be so shaped as to cover that also. Further, it had to be adapted to means for assembling to the hub. Thus all of the early hub caps were mostly cups, formed as a nut on the closed end and threaded on the open end for attachment to the wheel. The utility function was subsequently modified, but the impress of the original hub cap remained for years to give the character to all following types.

To the artist the problem was presented to apply the potent factors of form, size, finish, and decoration to this hub cap as a subject. At the start, certain basic structural changes were indicated. The points of emphasis had to be changed. Here, for example, was a hub cap that suggested in its form two obvious functions: to inclose a projecting axle, and to fit a wrench jaw for screwing it off or on. Clearly, neither of these suggestions contributed to the external appearance of a fine automobile.

IN analyzing the subject the question of approach was. "What, from an artistic standpoint, is a hub cap?" Obviously, it is the "attention center" of the wheel; but the wheels are the support and a part of the driving and steering gear of a car. This reflects itself in the appearance of the wheel. The wide and substantial tire, the firm and positive rim, the compact spokes or cross-meshed wires, all bespeak the functions, and not the functions merely, but also a strength and stability which suggest power and reliability in the functioning. What then can the artist do with the hub cap to improve the appearance of the car? Certainly the dominant note must be of strength, but with it must go the companion suggestions of poise, lightness, movement. Hence emphasis is given the outer surface; the contracted, almost invisible neck; or the close connection with the plane of the wheel.

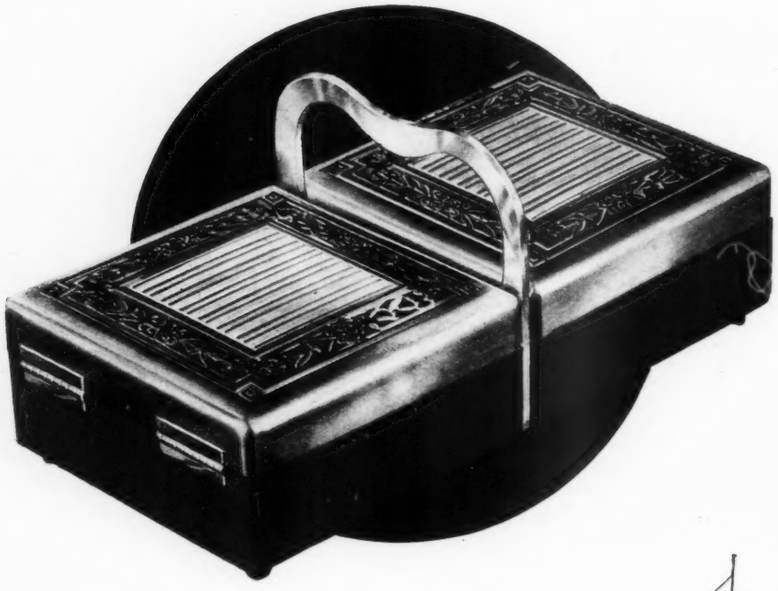
The attainment of a cap to embody these principles involved a mechanical problem. In the case of the wood wheel, to draw or cast a cup whose cap shall be no larger than the orifice is simple, and the original hub cap was little more than that. But to make one that should have a wide cap over a small neck, with the diameters of both in virtual independence of the size of the opening, was a very different matter. There were established ways of doing it but they were difficult and costly. The new design thus called for ingenuity and close co-operation by the plant engineers and changes in the wheel design.

In the case of the wire wheel, the evolution followed different lines, due to the different construction of the wheel and to the related problem of attaching to the hub



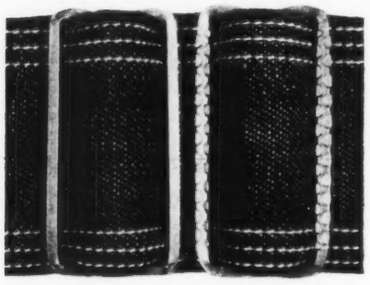
THE CARD HOLDER, cigarette case, and place-card holders shown are among the art metal products made in enormous quantities

METAL NOVELTIES are made mostly in brass and nickel-silver alloys and in steel. Ornamentation is done in enamels, plates, etching, embossing, or combinations. Styles and preferences in color change so rapidly that the designer must be constantly alert to observe trends, and the manufacturing organization must be always ready to change its operations



PAINT AND PLATING work are combined with die embossing. Although relatively inexpensive, this container is accurately made and finished

THE SIMPLE ART displayed in the overall belt buckle at the right below by adding the embossing operation and plating is found to add considerably to the sale value of the garment. Metal buttons are stamped with a design, or embossed sheet metal caps are pressed over the tops. The "modernistic" shoe ornaments at the bottom are stamped in one operation from rolled art metal with no plating necessary



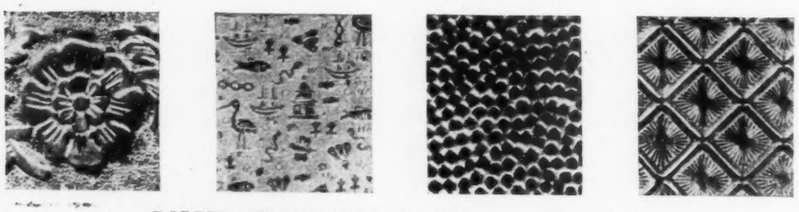
shell. There has been a striking development in wire wheel manufacture, and with this the hub cap design has kept even pace. In consequence, we find the hub cap in appearance now practically integral with the wheel. Here again there arose a practical production problem which involved much mechanical skill in its working out. It was the problem of simplifying the assembling of the cap to the hub. Originally the placing of the cap on the hub was done as a part of the production of the hub shell and thus of the wheel. Later there arose the need to handle the cap separately and to assemble and disassemble it at will. Such assembly had to be easy but effective, it had to lock tight and yet permit of expeditious disassembly at any time. In all this, the art department found its opportunity—and its difficulties!

In both the wood wheels and the wire wheels, the revised forms of hub caps as artistically designed have utterly subordinated the original aspects of the piece. The original truncated cone has reversed itself, or has melted down to a disk, and in these several ways has assumed more and more of the dimension and shape which accord with the general character of the car of which they are so conspicuous a part. It also has lent itself to variety of surface design that displays the sign of the maker, and is adapted to any ornamentation.

AN EMINENT principle that must be before the designer of an art product is that the purchaser is buying skilled labor and not material, and therefore he should not skimp on material costs. The amount of metal involved in a vanity case, lipstick holder, or similar novelty, is actually small. The choice of metal is dependent upon the type of finish required and upon its durability. Brass alloys as base metals are widely used; but the light alloys are also available in large quantities. The difference in cost of the base metal is, however, only one of many factors, of which the cost of fabrication and finishing may overshadow any savings made by short-sighted selection of material.

Art is applied in a metal product in two ways, either in the form, or in the surface treatment. Form is a matter for the designer or artist, limited only by the mechanical working requirements of the part and the production facilities of the shop. Surface treatment calls upon the production departments to incorporate into the product by the best possible means the requirements of the artist in color, polish, or other surface appearances. Since color is in reality a physical result of a chemical condition, the choice of base metal to best produce a given plate or finish again enters the problem. Some plates or finishes will show to better advantage on one alloy mixture than on others.

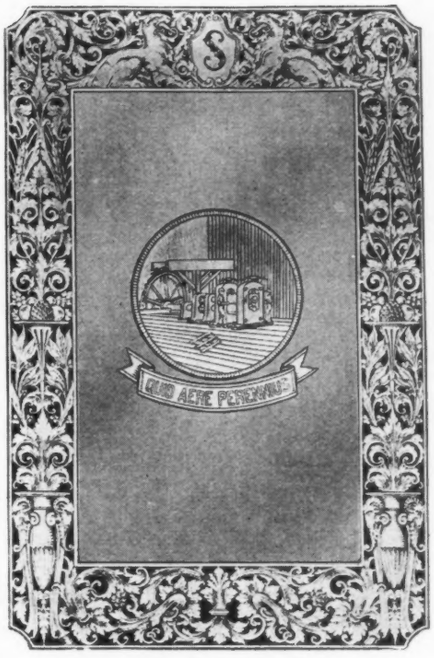
The surface treatments that are available for producing art work by finishing are: electroplating in all of the ordinary metals; natural finishes such as buffing, burnishing, chasing, and acid dipping; lacquering in all colors; enameling in all colors, either air-dried, baked or vitrified; japanning; etching; inlaying; die embossing; decalcomania; and printing. Many of these finishes, of course, serve a utilitarian purpose, such as corrosion resistance, as well as an



ROLLED ART METAL is available in numerous designs

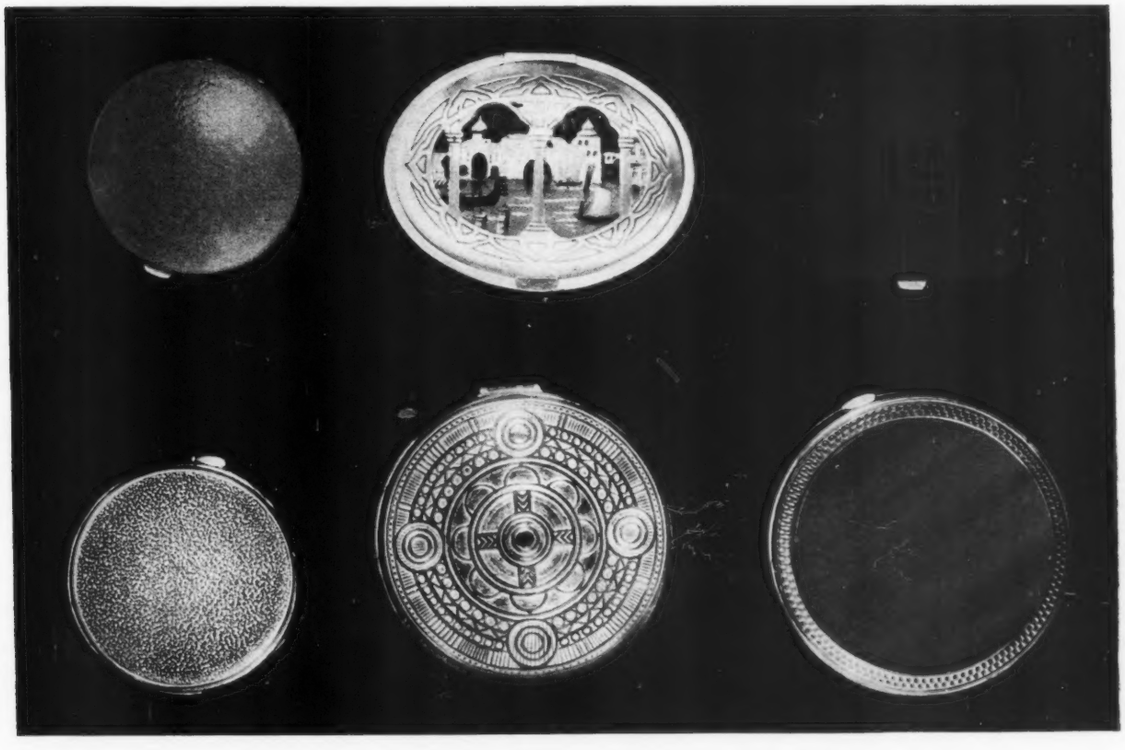
aesthetic or art purpose. Here again the artist must work in co-operation with the production departments to get the best results. Etching, for example, opens a broad field of possibility in obtaining delicate and intricate designs in metal that would be impractical by dies that would be difficult to make and would have only a short life. It is easily applicable, moreover, to curved surfaces. On the other hand, some more simple designs can be produced more advantageously with cut dies. In some cases a repetitive design can be rolled into the metal sheet before it is formed into the product.

Buttons offer a study giving a good background of applied art in a small product. The Scovill company began the manufacture of buttons in 1802, and has been making them continuously ever since. The design may be furnished by the customer, or the company artists make it up subject to the revision and approval of the customer. The base metals used are chiefly brasses, bronzes, or nickel silvers, but the applied decoration may be any one or a combination of surface finishes. In this class of product there are many designs that are universally used and hence can be stocked by the maker. There are also standard form designs which by an additional operation in the fabrication can be stamped or embossed with special worked-in designs desired by the customer. In calling for a new design, therefore, the customer has hundreds of bases on which to apply his finished design and also hundreds of finishes and color combinations through which an almost infinite variety of exclusive patents may be obtained from standard form designs with a minimum of complication in the manufacturing operations.



ETCHING offers the most facile method of decorating many products

The general principle in any art metal product is that the further along in the sequence of production operations the application of the art work can be delayed, the more economically can the product be manufactured. This distinction is, of course, of greater relative importance when the product is made in only a limited quantity. From the designer's standpoint, however, the proper application of the art work may call for a change in the basic form, or a change in the alloy, or both, in addition to the surface decoration applied in the final operations. To obtain the best and at the same time most efficiently economical results requires close co-operation between the designer and the shop, not losing sight of the facts, of course, that the word economy does not mean cheapness, and that the customer is usually willing to pay more for an article, whether it is a button or a locomotive, that has a pleasing appearance.



WOMEN'S FASHIONS have kept the art metal designer busy. At the top are 1929 designs of compacts, the one at the right being double, with two compartments and two mirrors, but very thin. The 1915 model, lower right, is plain brass, large and thick. Next came decoration, then reduction in size

By H. F. PETERSEN
Chief Engineer,
Schatz Manufacturing Company

BALL BEARINGS

FOR LIGHT LOADS AND MODERATE SPEEDS

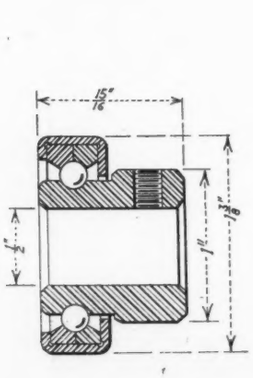
THE advantages of ball bearings are so apparent, and they have been demonstrated so frequently, that the desirability of using them in the mounting of rotating machine elements wherein low friction and good lubricating conditions are of any value, is seldom questioned. Yet there are many inexpensive machines wherein rotating members operate at a relatively slow speed and under a light load. These conditions do not warrant the application of the expensive, high-duty, ground bearings, nor do they permit the use of cheaply designed, toy ball bearings. Between these two extreme grades of ball bearings there is available an inexpensive type of ball bearing suitable for use at relatively low loads and speeds.

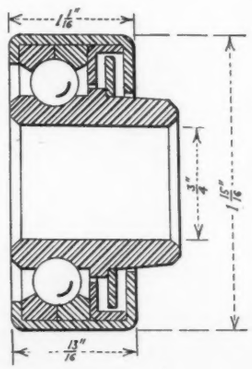
This "middle class" type of ball bearing is composed of an inner ring, a set of hardened steel balls, and two outer race rings with a shell closing over them. The construction is shown in the accompanying illustrations. All of these bearings involve the principle that anything which can be designed for production on the automatic screw machine and punch press can be made economically and still be kept within fairly close limits of accuracy. The inner ring of the bearing is a screw machine product, while the outer race rings are formed from flat strip steel. Both the inner ring and the outer race rings are carbonized, hardened, and tempered. The outer shell is formed from flat, strip steel, or it may be a screw-machine product turned from a solid bar, depending on the service the bearing is to perform. No parts of the bearing are ground, except the balls. Smooth action of the ball bearings is obtained by a "rolling in" process after the assembly has been completed.

The design of the bearings incorporates the three-point contact principle, giving the bearings a relatively large radial load capacity and a thrust load capacity in either direction. The rated thrust load capacity is up to 50 per cent of the rated radial load capacity of the bearing.

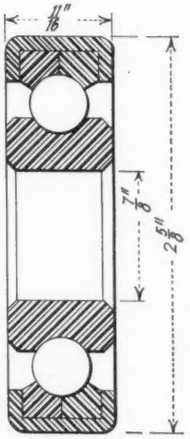
These bearings are made with tolerances of plus or minus 0.002 in. on the outside diameter and the bore, and a tolerance of plus or minus 0.010 in. on the width. The service for which these ball bearings are designed usually does not require either the inner or outer ring to be a press fit on the shaft or in the housing, hence the tolerances given are close enough. However, if close fits or press fits are required, they may be obtained by selective assembly. This is advisable in some cases.

Standard sizes of these bearings run from $\frac{1}{4}$-in. to $1\frac{1}{4}$-in. bores, though they are also made with a bore of $\frac{1}{8}$ in. Their rated radial load capacities at 600 r.p.m. range from about 15 lb. for a $\frac{1}{4}$-in. bearing to about 145 lb. for a $\frac{3}{4}$-in. bearing. At 50 r.p.m. the capacities are about $2\frac{1}{2}$ times these figures, while at 1,500

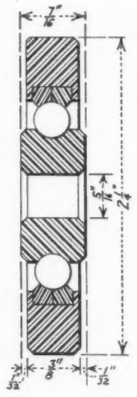




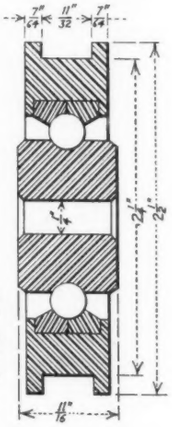
THE "STANDARD" ball bearing of this type consists of an inner ball race ring turned out of bar stock, steel balls, a two-piece outer race stamped out of strip steel, and a pressed steel outer shell which houses the outer race ring



A HEAVY machined ring is substituted for the pressed outer shell when the ball bearing is a combined bearing and roller



THE TREAD of the heavy outer ring may be plain, grooved, or flanged. These bearings are for elevator gates

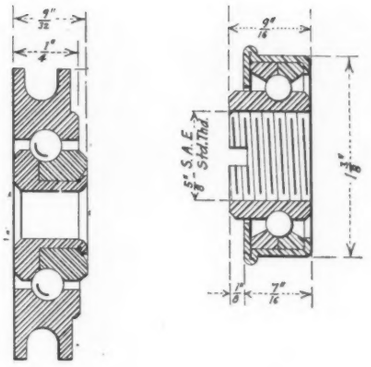


THE OUTER shell may be flanged inwards, leaving a small clearance to be sealed by heavy grease to keep out grit. The inner ring is of special construction. The smaller bearing to the left is used on children's vehicles. The larger is a bearing for belt conveyor idler rollers

r.p.m. their capacities are about one-half of those at 600 r.p.m. These capacities are, of course, for smooth running conditions. If the bearings are to be subjected to shocks or suddenly applied loads, their capacity will be correspondingly less.

Probably one of the most striking features of the ball bearings, as shown in the illustrations, is the flexibility which they offer to the designer because of the great variety of forms of inner and outer rings to choose from, as contrasted against the practically entire absence of such a feature in the standard, high-duty field of ball bearings. The reason for this feature, in the case of these "middle class" ball bearings, is the ease with which the design of the screw machine product, that is, the inner ring or heavy outer ring, may be varied without entailing great tool costs, as in the case of the high-duty bearings. It is for this reason that such a large variety of bearings of this "middle class" can be offered at relatively low prices. Indeed, when the number of bearings required warrants it, any special type of inner or heavy outer ring may be obtained economically.

It may be noted that two types of outer shells for these ball bearings are shown in the illustrations, one with the outer ring a sheet steel casing, and the other using a heavy outer ring cut from bar stock. This latter type is used when the ball bearing is to act as a roller or a wheel.



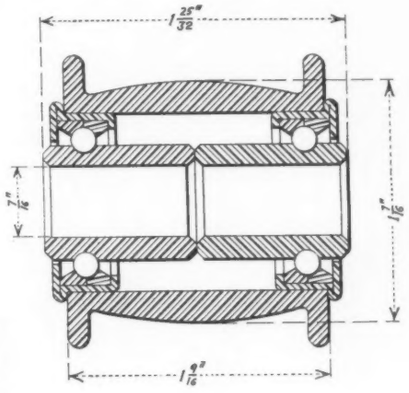
TO OBTAIN a minimum outside diameter the outer race is machined into a heavy ring while the inner race is formed by riveting together two rings

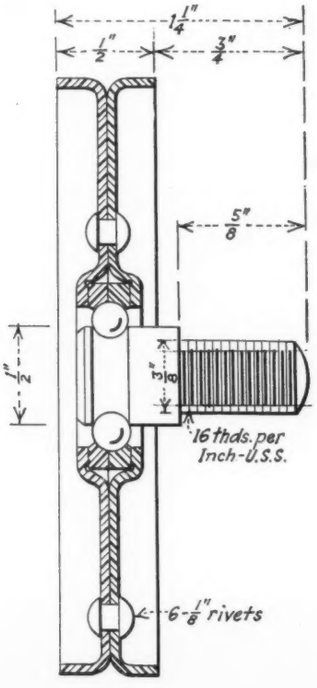
The ball bearings having the outer shell of formed sheet steel are made in a variety of designs. In one, the outer shell is cupped in to within 0.01 in. of the outer surface of the inner piece. This acts as a dust guard. This construction may be elaborated upon, as illustrated by the ball bearings for conveyor idler rollers. Another type of those with sheet steel outer shells has a flange formed on its outer surface to act as a locating ring for the bearing.

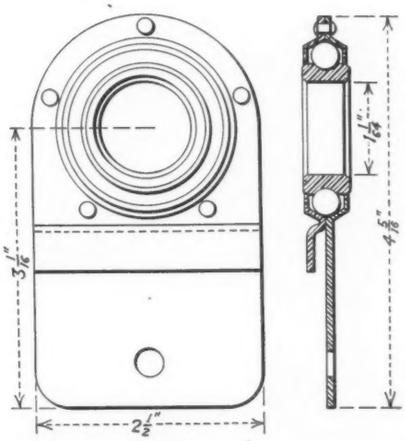
The features of flexibility described above enable the designer to incorporate these ball bearings in the design of his machine in such a manner that this unit not only serves as a bearing, but its inner ring or outer shell, or both, may also act as another related element of the machine. The illustrations show instances wherein the heavy outer shell also functions as a grooved or flat rim wheel; as well as cases where the inner ring is designed to serve also as a stud shaft or a wheel hub. In some designs, the outer ball race rings are dispensed with entirely, the outer ball races being formed in the outer shell, and the outer shell also being shaped to simplify the installation of the bearing in the machine. Such construction is shown in the illustrations of the bearings for the washing machine wringer and the door hangers.

The relatively low cost and the many possibilities of economies attained by designing the inner ring and outer shell of these ball bearings to conform to the related elements of the machine make available to the designing engineer an "anti-friction" bearing the use of which makes it possible, in many cases, to improve his product greatly at a small cost.

THE FLANGE on the tread of the outer shell is also standard. This ball bearing is used on the crank shaft of a sidewalk bicycle. The flanged tread eliminates the necessity of counterboring in order to locate the bearings, as illustrated by this pulley mounted on ball bearings



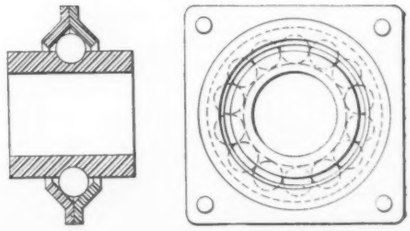




A MODIFIED FORM of outer shell is shown at left. It is made up of two pieces suitably formed and riveted together to function as rollers for gravity conveyors

THE BALL BEARING door hanger, at left, uses a two piece outer member, the construction being in principle very similar to that of the gravity conveyor rollers shown on the left

THE OUTER member of this ball bearing for which wringers, shown below, is made square to prevent rotation but yet allow it to slide in guides



COMMENT AND SUGGESTION

Weight Saving in the Mystery Ship

WHAT can be done with engineering research and design to meet a given field situation is exemplified in the new German "mystery ship" Ersatz Preussen. Limited very definitely by the displacement maximum of 10,000 tons set by the Versailles Treaty, German naval engineers have redesigned from top to bottom, taking advantage of the newer alloys, using welded sections instead of riveted ones, and designing every part with weight saving in mind. The result has been the development of an entirely new type of warship, heavily outclassing in armament any existing ships of the same displacement. It is slightly slower in speed than the modern cruiser, which, however, is considered secondary in conjunction with the greater range and greater weight of guns. Careful design in this case has resulted in a reduction of several thousand pounds in tonnage—enough to permit the mounting of 11-in. guns instead of the usual 8-in. guns on ships of this class. The ship is, in fact, in a class between the battleship and the cruiser, with armament advantages of the former and speed advantages of the latter.

■

Erasing on Drawings

By George A. Fries

DRAFTSMEN sometimes use a soft pencil in making a drawing because the lines are blacker and easier to erase than those made with a hard pencil. In attempting to erase errors made in tracing such a drawing, the soft pencil mark may be offset, by the pressure on the eraser, from the drawing to the back of the tracing. The draftsman will often mistake these pencil marks for ink, and continue erasing until he has worn a hole through the cloth. I have also noticed that, in most cases, mistakes on tracing cloth are scratched out by using razor blades or some other sort of scratcher. Usually the erasing is over done, leaving a scratchy appearance on the surface of the tracing cloth which shows up in the blueprint. If it is attempted to ink in other lines over the scratched surface, the ink spreads and leaves a messy appearance.

From my experience I have found the following method to be the best for erasing on tracing cloth: Place a triangle or some piece of celluloid under the tracing and rub lightly. Do not attempt to use a hard ink eraser or glass eraser. By patiently rubbing with the pencil eraser the ink line will gradually disappear without apparently destroying the surface of the linen. This procedure will not cause the ink to spread when new lines are drawn over the erased section. Finishing the process with an art gum eraser will also help iron out the sharp creases made by the blade of the ruling pen. The cloth should be held smoothly spread between the fingers so that the eraser will not catch and wrinkle the cloth.

■

STOP... LOOK... LISTEN...

. . . FASTER THAN THE BREMEN . . .

LEST everybody be misled by publicity artists into the false conclusion that the North German Lloyder S.S. Bremen is the fastest vessel of comparable size afloat, readers may note that Uncle Sam has a pair of cruisers that are considerably faster. We refer to the Lexington and Saratoga.

One of these aquatic airdromes has been known to transport itself from Los Angeles, California, to Honolulu in 72 hours, averaging 31 knots—That's steaming!

Incidentally these same carriers, with their full complement of airplanes, are reported to be by far the most potent weapons possessed by any navy in either hemisphere. Uncle Sam employs some good product engineers.

. . . OUR SPEED AGE . . .

WITH properly constructed road beds, steam train speeds of 110 to 120 m.p.h. are called entirely feasible today, and are needed to meet airplane competition. At the same time aeronautic engineers talk of boosting the speed of commercial passenger planes to 200 m.p.h.! In that event, they say, the modern business man will not "ride" sleepers. He'll be able to travel half way across the country between 6 and 10 p.m., and then get a good night's rest in a hotel bed,—that is, if they don't have something better than beds and hotels by the time such speed is common in commercial travel.

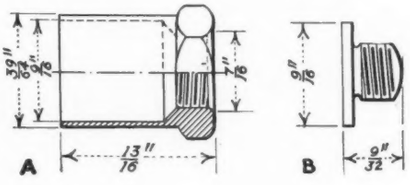
. . . BIGGER AND BETTER . . .

A CERTAIN professor of engineering we know delights in telling the story of a woman who, when she called at a haberdasher's to purchase collars for her husband, was promptly shown an assortment of size 13. Amazed that the clerk appeared to know the size her spouse wore, she

Economy with High-Priced Materials

By G. B. Stuart

DESIGNERS must take into consideration the operations of production and the probable labor cost of the parts going into their design if their plant is to turn out the best product possible in the most economical way. It sometimes occurs that small parts, especially parts made in the screw machine, do not need to be of steel either for strength or wear qualities, and would be more effective in brass, bronze, or aluminum alloys. Where the labor cost in machining the part is likely to be high, the designer can often call for these higher-priced alloys in the part and still keep the final cost down



below that of a steel part because of the saving in labor in machining and saving on tools in the shop.

Two typical parts which were changed from steel to brass with a reduction in net cost of 40 and 38 per cent, respectively, are shown in the illustration. The data is taken

from an investigation made by the A. C. Nielsen Company. In the first of these, a nose sleeve, the net material cost, including deductions for scrap, was only $3.64 per thousand in steel as compared with $10.50 per thousand in brass. But the net labor and tool cost of making them in steel was $24.86 per thousand as compared with only $6.52 for brass. There was a net reduction in cost of $11.48 per thousand, while at the same time a better finished, more rust-resistant part was produced. In the same manner a net saving of $2.30 per thousand, or approximately 38 per cent, was made on the second part, a filler cap, by changing from steel to brass. In his choice of material, however, the designer must also be guided by the necessities for tensile strength or hardness in the product. Other factors may also enter, and where light weight is desirable he can choose one of the many aluminum alloys that at first consideration seem high in price. Parts of this kind, also, where the strength need not be greater than about that of cast iron, and softness is not a detriment, can be die-cast with economy from zinc-base alloys and require no machining at all.

■

Decline of the U.S.S. Thread

By Andrew J. Schwartz

IN THE machine industry, the U.S.S. threads are fast losing favor. Since 1921, in compliance with an act of Congress, the Federal government has been required to use only the National form of thread. The General Motors Corporation also prohibits the marking of the words "U.S.Std." on taps, according to the latest specification.

Some firms still specify U.S.S. threads, but they are not particular in the requirements and the products are never gaged. One large automobile manufacturer combines both systems, that is, drawings call for U.S.Std., Form III." This seems to be a confusion since the U.S.S. thread has but one class of fit. However, the National form thread has three classes of fit.

At the Cleveland Machine Tool Exposition, all gage manufacturers had gages and descriptive matter on the National form. This thread is also approved by the Tap, Die, and Chaser Manufacturers, and will eventually entirely replace the U.S.S. thread.

asked him how he guessed it, and received the reply, "Well, madam, no husband with a neck larger than that permits his wife to buy collars for him!"

Before long it may get to the point in railway engineering where, to be regarded as a real "he" tractive unit and avoid the risk of being considered a member of the "13-collar" class, a locomotive will have to operate under steam pressures of at least 300 pounds. At the recent annual A.S.M.E. meeting talk in the railway session centered around new locomotives designed for pressures up to 1,470 lb. "Iron horses" developing as much as 10,000 hp. are being spoken of as quite within the realm of possibility.

. . . STILL BETTER VALVES . . .

POPPET valves, despite the marked improvements made in recent years, continue to be a limiting factor in large-cylinder gasoline engine design, according to chief engineer Charles O. Gurnsey of the J. G. Brill Company's Automotive Car Division. Two exhaust valves per cylinder give longer service than one, but metal that will stand up still better and run cooler under the high temperature conditions encountered is wanted—Who'll develop it?

. . . DEAD WEIGHT . . .

THAT surplus weight costs about ½ cent per ton mile to haul around in automotive-type railway cars, is another point made by Mr. Gurnsey. Perhaps it costs less for steam trains, but dead weight does increase operating costs. Lighter weight passenger coaches are being built, but the wide possibilities of weight saving in rolling stock are not getting excessive recognition.

. . . RESEARCH—NOW . . .

IT doesn't require an engineering education to appreciate the importance of continuing research and development work under full steam when business tends to slacken its pace. Executives called together by that engineer whose "laboratory" office is in the White House just now, have been wise in stressing this point. Manufacturers who fail to realize this fact are likely to awake some fine morning to find in the field new products destined to knock antiquated ones into a cocked hat — And it doesn't take long these days for a product to become antiquated.

. . . CAM-FED MILLERS . . .

AUTOMATIC regulation of the speed of cut on a production milling machine in proportion to the cross-section of the cut seems like a logical procedure even though a special cam-feed is required. Equally logical is the application of a flywheel to one end of the cutter spindle as a means of reducing chatter. Whether or not either feature is as new as the use of artificial sun-tan doubtless is a question that received scant consideration when both features were incorporated in a milling machine by Kent-Owens designers.

A Rapid Method of Cross-Hatching

By Don R. Hammitt

CROSS-HATCHING pencil drawings or tracings can be done rapidly and at little expense by using a sheet of ordinary ribbed window glass. The glass, which should be about 6x10 in. in size, with rib spacer of about $\frac{1}{16}$ in., is placed beneath the drawing or tracing sections which are to be cross-hatched. The plate of glass may be so placed that the section lines will appear in any desired direction.

A wax pencil, preferably blue or black, such as is used in checking, is rubbed over the drawing sections which are to be cross-hatched. A flat, blunt pointed pencil stroked in a direction perpendicular to the ribs in the glass below will give the best results. A little practice will give any draftsman the knack of cross-hatching properly by this method. Such lines appear well on blueprints.

■

The Elderly Engineer's Place

By Robert Pilkington

RECENTLY, the industrial world has been passing through what I believe to be a purely temporary phase of its activity. I refer to the present tendency to employ only young engineers, or as the advertisements read, men from 25 to 35 years of age. The requirements all include the condition, "University education and experience." It seems rather unfair to expect a man of that age to acquire enough experience to make him worthy of a position of much responsibility, for without decrying the university education, having that background myself, it still is true that a man has much to learn after he gets out of college.

There are still a few plants where it is the custom to "catch them young and train them up," but the necessity for this practice is much less than it once was. Good, conservative engineering knowledge is much more widely disseminated than it has been, and a real engineer can grasp the requirements of almost any kind of work with fair promptness. In other words, a man with many years' experience in one line will in most cases be more valuable in another line than the young and inexperienced man. The fallacy of the old belief that an engineer must be trained for a certain position and held there indefinitely has been exploded.

In fact, any engineer blessed with

the ordinary amount of common sense becomes more valuable in his professional skill every day until he reaches the point where mental decadence sets in. This is a very uncertain period. Men like Thomas Edison and Henry Ford, for example, are just as active mentally today as they were 25 years ago, despite the great strains they have gone through.

The older man has a great fund of experience gained by trial and error that no younger man can duplicate. I will cite a leaf from my own diary. It concerns a truck that was designed, constructed, and placed on the road in less than three and a half months. Only by avoiding a lot of previous mistakes and taking short cuts culled from thirty years' experience in designing and building trucks, was I able to achieve this record. How many men under 35 would have been aware of half this specialized knowledge?

And yet there is a leading concern in the Middle West whose policy requires action by the board of directors in order to hire a man over 35 years of age. This huge corporation gets its engineering skill by continually advertising in the daily newspapers, using two or three times as much space for the purpose as any other concern with which I am familiar. Its engineering turnover is so great, however, that it is difficult to see how any one of them can stay long enough to be of any real value. That the company succeeds with this policy is because of the aforementioned engineering knowledge.

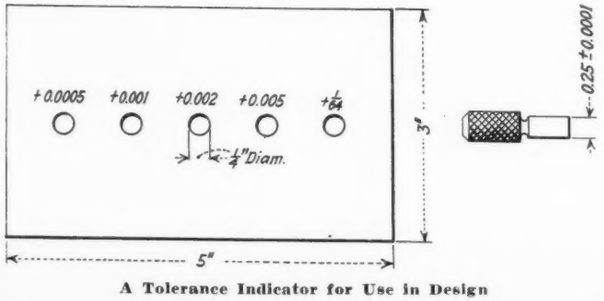
■

A Tolerance Indicator for Use in Design

By Charles E. Kirkbride, Jr.
Project Engineer, Naval Aircraft Factory

In order to indicate quickly and clearly just how much perceptible shake or play will be present with various tolerances, the block and plug gage shown was made up several years ago. The block is made of $\frac{3}{4}$-in. stock, all holes being $\frac{7}{8}$ in. apart and lapped to a tolerance of plus or minus 0.0001 in. The plug is of tool steel, hardened and ground, and has a knurled head. Other dimensions are shown in the drawing.

The set is being used continually in the design room for the purpose intended, and has grown so essential in everyday work that it was necessary recently to order the making up of an additional set.



A Tolerance Indicator for Use in Design

■

Celluloid Templets

By Ralph M. Gamble
Machine Designer
Jones and Lamson Machine Company

A CONSIDERABLE improvement over the old style paper templets in the form of clear transparent celluloid of $\frac{1}{64}$-in. thickness is used in a Connecticut factory. These templets can be used directly on the work by the machinist or tool maker, and their use forms a short cut between drafting room and shop, eliminating all other mediums and their many chances of error. The cost of this material alone is little more than the best of steel or cardboard that is commonly used for the same purpose, and the saving in labor, together with the high degree of accuracy obtained, has proved that this method of transfering shapes from the drawing board to the article is truly valuable.

For best results one should use celluloid that has not been rolled up, as a peculiar characteristic of this substance is that it cannot successfully be made to stay flat after it has been left in a roll. It is merely necessary to place a sheet of celluloid over the drawing of the object, fasten it down at the corners with regular thumb tacks, and proceed to trace the outline, using a small scratch awl in combination with the French curve or straight edge that fits the shape on the drawing. A true radius can be made with bow dividers or a beam compass with a steel point.

After the outline of the curve has been marked deep enough to form a track for the scratcher, the templet can be cracked off, and with the use of a small, fine-cut, half-round file such as diemakers use, the bumps can easily be removed.

Making a celluloid templet requires no great amount of skill or time and is considerably less expensive than making steel templets. Also, the templet is traced through by the draftsman from the original layout. Making the templet in the shop from a blueprint requires the toolmaker to lay out the profile of the desired curve. In such a procedure, particularly when the profile contains irregular curves, the chances for error are numerous. By having the draftsman make the templet the possibilities of errors creeping in are very greatly diminished.

■

A Wrench Clearance Templet

By L. Coon
Draftsman, Kellogg Manufacturing Co.

In laying out bolt holes near a side wall of a casting, much time can be saved by putting the triangle to use as a templet for laying out the necessary wrench clearance. The

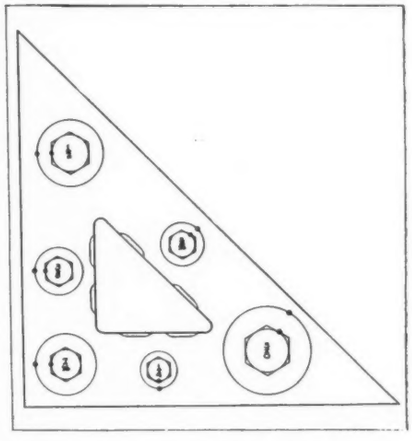
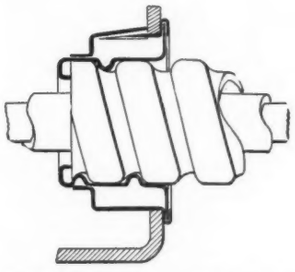
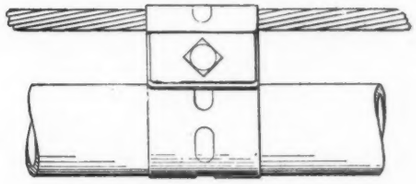


Fig. 1—Outlines of various capscrew heads and the appropriate washers can be etched on the triangle, as shown, in order to provide means for determining the wrench clearance necessary

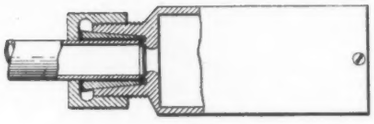
accompanying illustration shows such a triangle etched with several outlines of capscrew heads and appropriate washers. These can be laid out full size. It will be noted that a small hole is drilled on the flat side of the capscrew hex and another at the edge of the washer. In determining the size of the boss and the location of the center of the bolt hole, the outline of the capscrew specified is laid in position on the drawing and a prick punch is used to indicate the position of the hex and position of the washer. All of the washers used permit the operation of a socket wrench in the space provided.



1,725,883—Outlet box cable connector

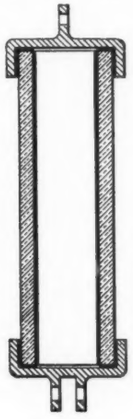


1,725,120—Messenger cable support

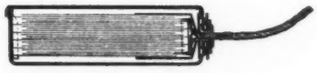


1,725,853—Conduit box

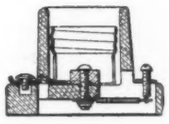
ELECTRICAL
Parts and Accessories
RECENTLY PATENTED
United States patent number precedes each caption



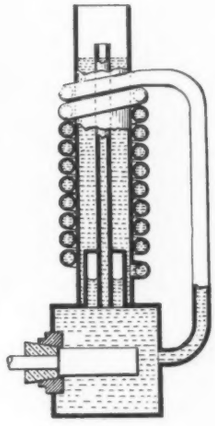
1,728,531
High-voltage insulator



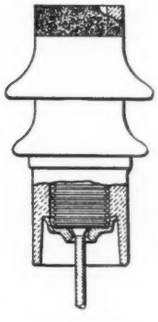
1,726,774—Metal-cased condenser



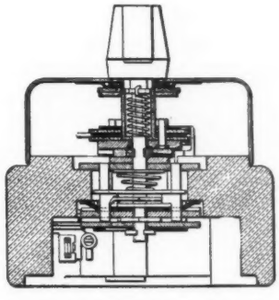
1,728,627—Flashing receptacle



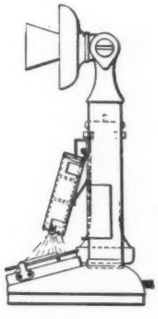
1,727,963—Electrolytic rectifier



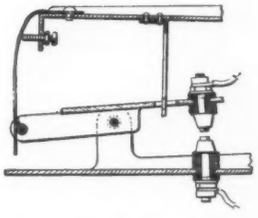
1,728,559—Lightning arrester



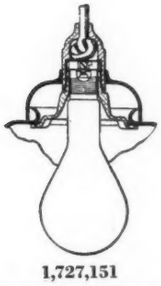
1,728,794—Snap-switch circuit breaker



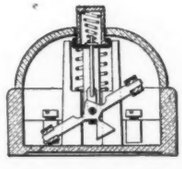
1,725,430—Telephone-dial light



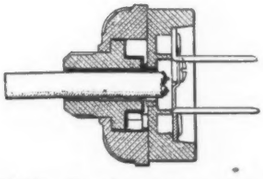
1,727,249—Thermostatic regulator



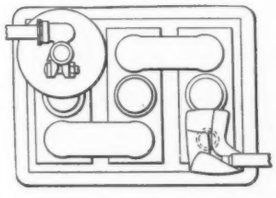
1,727,151
Lighting fixture globe holder



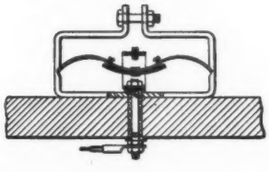
1,726,897—Push-button switch



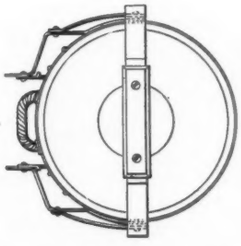
1,728,549—Combined switch and plug cap



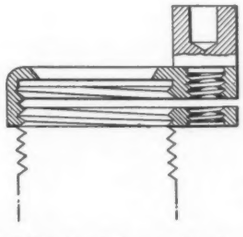
1,728,319—Battery terminal protector



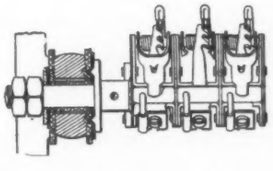
1,726,748—Thermostatic control switch



1,728,751—Sandwich toaster

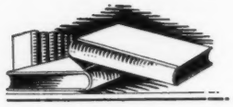


1,728,280—Conduit-grounding bushing



1,727,917—Brush mounting

Books for Engineers



MATERIALS HANDLING EQUIPMENT. *By Edward J. Tournier, estimating engineer, Robbins Conveying Belt Company. Three hundred seventy-one 6x9-in. pages, cloth-board covers. 146 illustrations. Indexed. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Price $4.*

WHILE not a book aimed to cover design details of the equipment employed in materials handling, it is nevertheless a comprehensive engineering treatise on the equipment in successful use, and on the economics of the various types. It will give the engineer an excellent background of the whole subject.

Beginning with a brief historical sketch, showing early types of conveyors, the book has twenty-two chapters taking up separately the types of conveyors adapted for different handling requirements. It is well illustrated with halftones and line drawings of the conveyors, installations, and parts. Twenty pages are devoted to the definitions of terms and equipment used for all kinds of conveying. Another chapter is given to the explanation of general principles and classification of conveyors.

✦

MACHINE DESIGN. *By P. H. Hyland and J. B. Kommers. Four hundred forty-eight 5½x9-in. pages. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York, N. Y. Price $4.00.*

THOUGH the authors infer in their preface that the book is not intended as a general reference book, this volume should prove of value to the practicing engineer as well as to the teacher and student of machine design. The book is replete with diagrams, illustrations, and tables setting forth general data for machine design.

Beginning with a discussion of general considerations and procedure in design, the book continues with chapters on shop processes, kinematics, materials of construction, mechanics of materials, and then takes up individually the design of various machine elements. The fundamental formulas of mechanics are not derived, but the derivation of design formulas based on them is given for each case. Numerous problems for classroom work are given at the end of each chapter. A chapter on safety engineering completes the text. An appendix of eleven pages contains tables giving the composition of various ferrous and non-ferrous alloys.

✦

REPORT WRITING. *By Carl G. Gaum and Harold F. Graves. Three hundred nineteen pages, illustrated, 5x9 in. Cloth board covers. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York City. Price $5.*

AN UNUSUAL text, written by two capable men, an engineer and a professor of English, this book is practical and valuable to the present-day student of the fine art of writing technical reports. Deliberate precision was used by the authors in constructing the work to show where and when each report-factor enters, and numerous special types of reports are then presented to emphasize the discussions, which advance progressively from the more simple types of reports to the more complex. Samples of business letters and illustrations for reports are also included.

Although planned for a text to be utilized in courses covering its subject matter, the practical man in search of an up-to-date, easily reading presentation of the facts of report writing will do well to consider this book. And with the increasing necessity for reports and business letters which sell themselves to the executive of today because of their clarity and conciseness, this text should prove a boon to the man who finds himself very much in need of assistance.

✦

THE NATURE OF THE PHYSICAL WORLD. *By A. S. Eddington, Plumian Professor of Astronomy, University of Cambridge. Three hundred sixty-one pages, 6x8¾ in., board covers. Published by the Macmillan Company, 60 Fifth Ave., New York. Price $3.75.*

ENGINEERS and other trained thinkers who have not become so engrossed in practical problems as to lose their interest in the amazing developments in knowledge which students in the "pure" sciences have uncovered in recent years will find in Professor Eddington's recent book an engrossing and thought-provoking outline of the physical universe in which we live.

It is not a book for light reading, but one in which the intelligent mind with a scientific bent delights. It is a lucid exposition, not alone of Einstein's theories, but of those advanced by other great thinkers of the modern schools. As a result of the author's explanations, time, space, and gravitation take on new meanings. The quantum theory, in its relation to matter, acquires a new signficance. So also, in a score of other directions, the reader finds himself brought up to date not only in respect to "the new physics," but with a much broader outlook upon science as a whole.

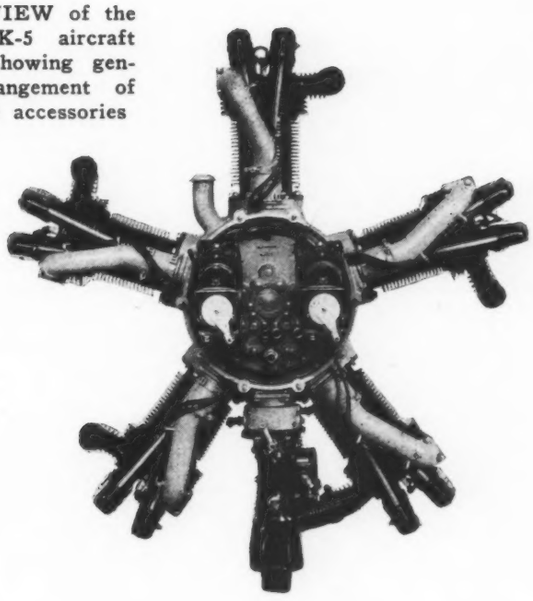
The author, himself an eminent scientist, fortunately possesses and puts to good use an unusual ability to translate into the terms of common experience a subject ordinarily abstruse and difficult to comprehend.

✦

HYDRO-EXTRACTORS—THEIR SAFE CONSTRUCTION AND EQUIPMENT. *One hundred two 4¼x7¼ pages. Paper covers. Published for the International Labor Office (League of Nations). Distributed in the United States by the World Peace Foundation, 40 Mt. Vernon St., Boston, Mass. Price $1.00.*

THIS is the second of a series of studies on individual problems in accident prevention that the International Labor Office has published, the first being on safety in the use of chains. One chapter of this present monograph on hydro-extractors or centrifugal dryers is devoted entirely to an exposition of the stresses to which the different parts of hydro-extractors are subjected to, and presents the design formulas to be used in calculating these stresses. Another chapter covers details of construction, describes various designs in general use and sets forth the fundamental considerations underlying the different types. There are 40 pages devoted entirely to engineering considerations in addition to a chapter showing designs of safety devices applied to hydro-extractors.

A short bibliography is given, followed by an appendix wherein four typical accidents caused by centrifugal extractors are described.



REAR VIEW of the Kinner K-5 aircraft engine, showing general arrangement of cylinder accessories

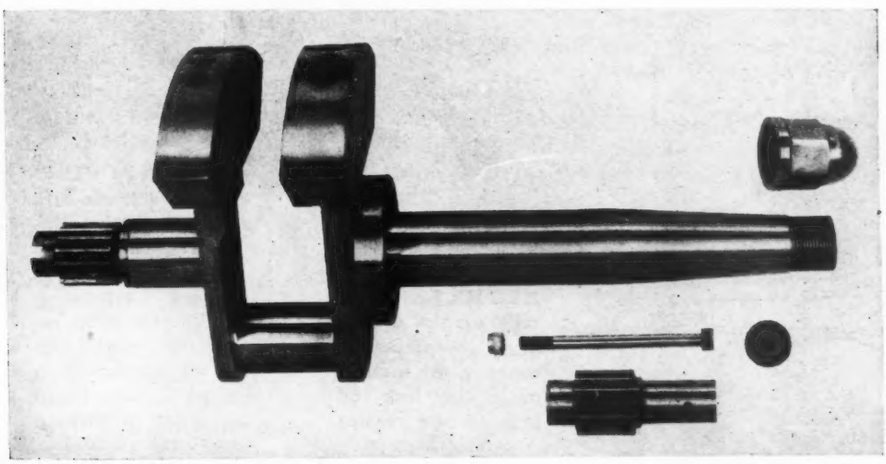
A TYPICAL MODERN AIRCRAFT ENGINE

Five, 4¼x5½-in., forged steel cylinders give a displacement of 372 cu.in. and develop 100 hp. at 1,700 r.p.m. The compression ratio is 5 to 1. Crankcase and cylinder heads are cast from the light aluminum alloys

SINCE the Kinner Model K-5 airplane engine embodies no radical departures in design, it may be termed a typical or representative example of the moderate-power fixed radial-cylinder aeronautic engine of today. It is characterized by its makers, the Kinner Airplane & Motor Corporation, as an "improved" rather than a "new" engine. Partly because of its conventional and well-tried type of construction, perhaps, it has come to see quite extensive use in two- and three-place planes requiring about 100 horsepower.

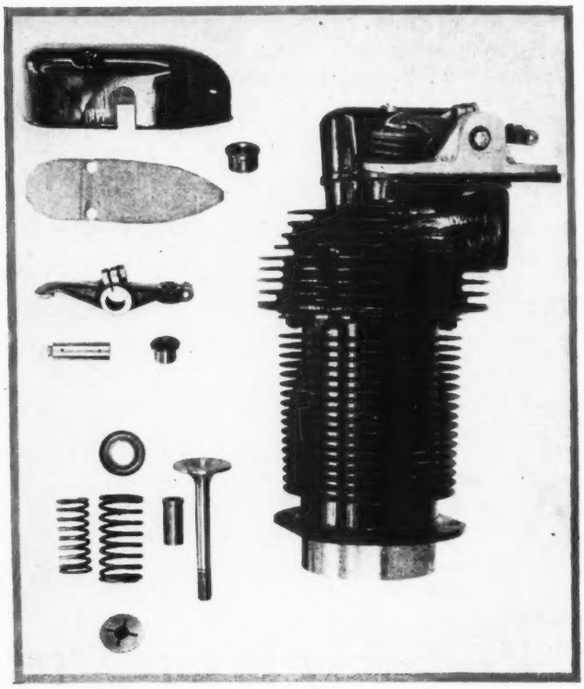
Bureau of Standards tests show that this engine, having a stroke of 5¼ in., five cylinders of 4¼ in. bore, and a 5 to 1 compression ratio, develops 100 hp. at 1,700 r.p.m., and 113 hp. at 1,880 r.p.m. Its power-speed curve approximates a straight line from 1,400 to 1,900 r.p.m. The power output at the last-mentioned speed is almost one horsepower for each 3.2 cu.in. piston displacement, or slightly over one horsepower for each 2½ pounds of dry weight (accessory weight not included).

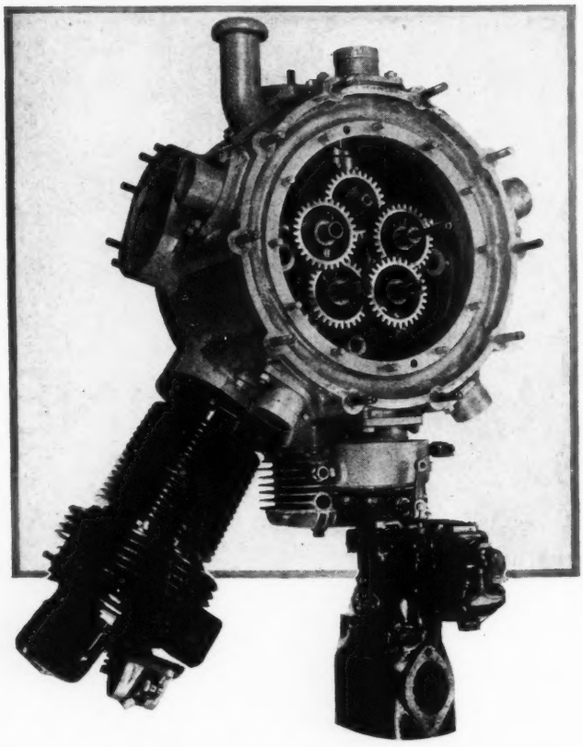
As accompanying cuts indicate, the crankcase is an aluminum alloy casting, roughly cylindrical in form, except for the flanged projections for the cylinders and other bolted-on parts. This casting, made by the Bohn Aluminum Corporation, has front and rear covers that support the two plain bronze-back babbitt-lined bearings for the single-throw crankshaft and a radial ball bearing to take the thrust load of the propeller. The rear cover carries also the bearings for the five cam gears and supporting flanges for the oil pumps, starter, and magnetos. A hollow annular ring, cast integral with the crankcase, is connected to the carbureter



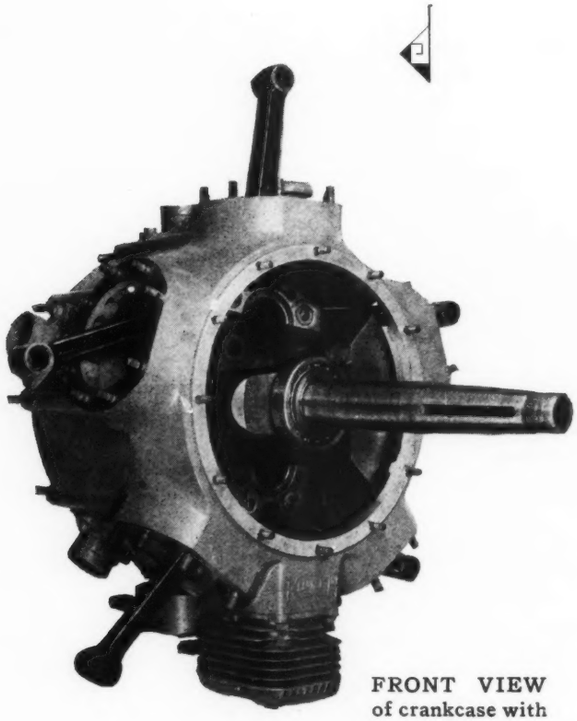
CRANKSHAFT assembly and parts. The pinion is held in place by the through bolt and is locked against turning in reference to the shaft

AT THE RIGHT, cylinder, cylinder head, and valve parts are shown. The pressed metal cover used to inclose the rocker assembly is stream-lined to reduce air resistance. The Alemite fitting for lubrication of the rocker pin projects through this cover

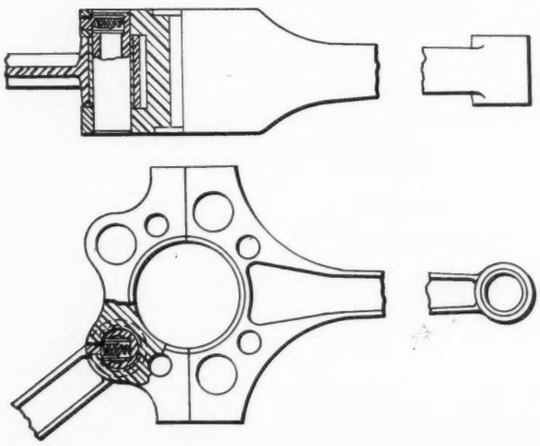




REAR VIEW of crankcase with one cylinder, oil sump, carburetor timing gears, and tappet assemblies in place. The annular intake manifold can be seen just inside the core flange. Bearings for the gear shafts and crankshaft are carried by the cover plate, which has been removed



FRONT VIEW of crankcase with cover and cylinders removed and master rod bearing separated. The oil sump below bolted to the crankcase is well finned to assist in keeping the oil cool



AT THE LEFT, details of the master rod construction, showing the method of locking link rod pins to the master connecting rod

below, and to each cylinder inlet port by a flanged tube with a rubber sleeve joint adjacent to the crankcase.

Each cylinder is a carbon-steel forging flanged at the base for attachment to the crankcase and at its outer end for attachment of the heat-treated aluminum-alloy head. The latter is a one-piece casting with fins for heat dissipation. Cylinder cooling fins are turned integral with the forging, which is machined all over.

Valves, of which there are two per cylinder, are forged from Ferrochrome C steel, and are interchangeable. They are of "tulip" shape, and are made hollow for lightness. Each valve is held to its seat by a double helical spring, and is opened by a rocker arm pivoted on the head casting and actuated by a hollow push rod with spherical ends. Valves are placed on an angle to the cylinder head, which has a "gable-roofed" combustion chamber similar in shape to that in the Liberty engine. Valve guides are of a special bronze alloy pressed into place, while valve seats are of hard aluminum-bronze and are shrunk into the head. This metal is used partly because it assures good thermal conductivity, thus aiding to keep the valves cool, and partly because if forms a seat with satisfactory wear- and heat-resisting qualities superior to those of the head casting. A stream-lined pressed-metal cover encloses each valve and rocker assembly, excepting for the Zerk fitting on the end of the rocker pivot pin, which projects through the cover to provide a convenient means for applying lubricant.

Cam-followers are of the roller type, and, being within the crankcase, are lubricated by the splash of oil thrown off the connecting rod bearings.

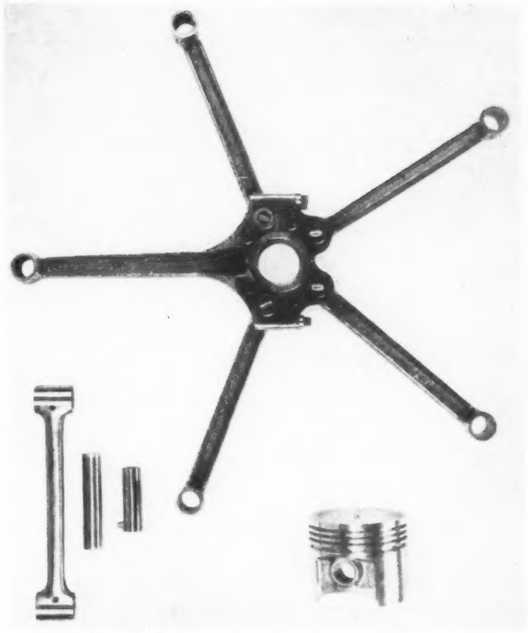
CHROME-NICKEL steel is the material employed for the one-piece crankshaft forging, which, of course, is extended to provide a mounting for the propeller on its tapered end, machined to conform to S.A.E. No. 1 standard. Bronze counterweights are bolted with three capscrews each to extensions of the crankshaft cheeks. The crankshaft is drilled to decrease its weight and to provide passages for oil to be fed under pressure from one of the two oil pumps to the two main bearings and the master connecting-rod bearing.

A second pump is employed to keep the oil sump, adjacent to the carbureter, dry, and to return the oil to an external reservoir. The two pumps are driven directly off the short shafts on which the two lowermost timing gears are mounted. These gears, and the three other timing gears, two of which drive the magnetos, mesh with a common pinion bolted to the rear end of the crankshaft.

Connecting rod design follows conventional practice for engines of this type. All rods are of chrome-nickel steel, and have an H section. In the big end of the master rod is a split bronze bearing with babbitt lining.

All other rod brushings are solid hard bronze. Lock pins of hollow section, retained by spring catches, hold the four link rods to the master rod. The pins have 0.002-in. clearance in diameter and 0.020-in. end clearance.

Pistons pins float in the rod bushings as well as in the bosses of the pistons. Aluminum alloy buttons pressed into the bosses keep the piston pins out of contact with cylinder walls. Pistons are permanent-mold castings of aluminum alloy. They have three ribs arranged to stiffen the skirt and to help conduct heat from the head to the skirt and the cylinder walls. Each piston has three compression rings and one oil ring.



MASTER ROD and link rod assembly of the Kinner engine. At the bottom are shown a piston, a piston pin, a link pin, and a link rod

Two sparkplugs are fitted in each cylinder head on the fore-and-aft diameter. The five front plugs are fired from one magneto and the four rear plugs from the second magneto.

All parts of the engine are readily accessible. Cylinders are easily removed for valve grinding and "top overhaul," while all parts in the crankcase can be reached and removed by taking off the end plates. The bare engine without oil or accessories weighs 280 lb. It is said to burn 0.55 lb. of fuel and to consume 0.035 lb. of lubricating oil per hp. hour.

■

Finishes for Zinc Products

ZINC is a metal that is susceptible to almost any of the common metal finishes, although it is necessary to observe certain precautions in order to obtain satisfactory results. Plating is a simple process, but because of the high position occupied by zinc in the electro-chemical series, it is necessary to apply a primary coating of nickel before the finish coat is deposited. Other metals such as chromium, copper, brass, bronze, silver, and gold can then be deposited on this nickel ground coat in the usual way.

Zinc weathers to a soft gray. To obtain other effects, artificial coloring is necessary, accomplished either by electro deposition or by chemical coloring. By treating the metal with various copper solutions, for example, several shades of brown and black may be obtained, simply by making small changes in the procedure. Colors produced by chemical means are fairly permanent for indoor use, but deteriorate rapidly outdoors.

To paint, lacquer, or enamel zinc successfully, the smooth surface should be roughened by pretreating or weathering. Wherever practical, natural weathering, from 2 to 6 months, is preferred, although a light sand blast is equally satisfactory. The surface may also be roughened by etching. Where none of these treatments is feasible, organic solvents are used to remove all grease and oil usually present.

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

January, 1930

Volume I, Number 1

AFTER many months of study by the editors and publishers, and with the experience gained from Product Engineering Numbers of *American Machinist, Product Engineering* inaugurates with this its first issue a complete service for those charged with exercising the industrial function known as product engineering. The editorial staff is made up of Kenneth H. Condit, editor; George S. Brady, managing editor; Fred H. Colvin, consulting editor; and George F. Nordenholt, Herbert Chase, Frank J. Oliver, Jr., and H. R. LeGrand. Co-operating with these men will be the full editorial staff of *American Machinist,* and back of them stand the resources of the McGraw-Hill Publishing Company.

■

Look to the Product

A CHALLENGE to the designer may be drawn from the first report of the new National Business Survey Conference, recently set up in Washington to interpret the trends in industry and to aid in smoothing out the business cycle.

The first suggestion is for "repairs, maintenance, clean-up, general betterments, improvement, re-equipment and replacements." Redesign of product might well be included. The time to make improvement in the product is when things begin to move slowly, or when changes in the plant and equipment are contemplated. Plant and equipment have one real object—to produce the product—and it therefore behooves the designer to fashion his designs so that they can be manufactured in the most economical manner, considering, of course, the attractiveness and salability of the article. In other words, the "end" as well as the "means" should be studied.

With product as the prime consideration on which plant and equipment depend, every engineering department in the country should stop a moment for reflection and detailed consideration of every factor governing its designs. Is the product what the customers want? Does it incorporate the right materials? Is it functioning properly? Are the smaller parts standardized? Shouldn't small units like screws and bearings be purchased from specialists? These are some of the questions that the designers should sit around the table and discuss—not later, but now, before the factory improvement plans begin.

■

Why Cramp the Designer?

IN BUYING machines for specific purposes, there are certain advantages in specifying the results wanted, rather than the details of the machine expected to produce the results. This, of course, is predicated upon the purchase being made from a concern with a reputation for good work and fair dealing, as well as one having extended experience in designing and building the general class of machine desired.

Unless the purchaser who specifies details of construction is in the unusual position of knowing more about machine design than the designers of the concern which is to build the machine, he is likely to base his specifications upon machines in use already. The probability, then, is that the new machine will be out of date and will lack refinements and improvements which the builder would incorporate if given a free hand.

Machine purchases to be made from the lowest bidder, however, may fall into a different classification, for in such cases the unscrupulous or inexperienced bidder usually becomes a factor. Then the purchaser may have to protect himself by specifying details.

But even then, it will usually be found that there is a wide gap between the estimated performance of a machine on paper and its actual operation, unless the concern building it is experienced and honest and is permitted to contribute its engineering skill to the development of the article. It should be given that opportunity.

PRODUCT ENGINEERING

✦ A Journal for a Fundamental Function ✦ of Increasing Importance

PRODUCT ENGINEERING, as a function, is a relatively recent industrial development. The conception, design and improvement of the product, of course, have always been someone's job, but they have not always been his whole job. A certain amount of production responsibility has been mixed in, or possibly a measure of plant engineering.

Of recent years, as management and merchandizing methods improved, and manufacturing units grew in size and in complexity, it began to be evident that product engineering, plant engineering, and production should be looked upon as independent functions. Not independent in the sense that they were unrelated and unco-ordinated, because with enlargement of units the need for departmental co-ordination grew, but independent in the sense that in one individual centered the responsibility and authority incident to the function. From this evolutionary period the product engineer, no matter what his title, emerged as the individual responsible for the physical characteristics of a product that would meet the requirements of purchasers and the demands of economical manufacturing.

For somewhat more than two years the McGraw-Hill organization has been studying the problem of product engineering and working out the best way to provide the product engineer and the executive interested in product engineering with the information, counsel and inspiration that can only be obtained through the medium of a high grade technical journal.

It was evident from the first that the product engineering function was developing so rapidly in the metal working field that it was no longer possible to meet its requirements through a paper that was also covering the highly complicated manufacturing problem. Hence an early decision to separate the two functions and to publish *Product Engineering* as a separate monthly magazine for the men interested in that function, *American Machinist* continuing as the weekly paper dealing with the operating, mechanical maintenance and other production phases of metal working.

Because it seemed wiser to make the separation of *Product Engineering* from *American Machinist* a gradual rather than an abrupt process, we have been publishing Product Engineering Numbers of *American Machinist* since last August. These transition numbers gave us the opportunity to discover the needs of the field, and enabled us to launch *Product Engineering* as a tried and tested publishing enterprise with the experimental work behind it.

On behalf of the editors I invite criticism of the contents and of the appearance of *Product Engineering.* It is their aim and the aim of the McGraw-Hill Publishing Company to make *Product Engineering* the best possible journal for its field; that aim cannot be achieved unless those for whom *Product Engineering* is published take time to tell us what they would like it to contain.

Product Engineering starts its career with a definite objective. To the attaining of that objective it brings the skill of an experienced editorial staff of its own and the backing of the whole staff of *American Machinist;* and behind those two groups the full resources of the McGraw-Hill Publishing Company.

It has already a paid circulation larger than that with which any other new business paper in our experience has ever been launched. Flattering as this response from the field has been, it is also a spur to all of us who are responsible for *Product Engineering* to do our utmost to make sure that that confidence is not misplaced.

NEW MATERIALS AND PARTS AND ENGINEERING EQUIPMENT

Columbia Intermittent-Motion Clutch

A CLUTCH that will produce smoothly the same intermittent rotary motion in one direction that can be obtained with a ratchet and pawl, but without noise and with no appreciable backlash, has been developed by the Columbia Industrial Machinery Company, 4020 West Lake St., Chicago, Ill. The company is in a position either to manufacture the device or license its use in machinery. Fig. 1 shows the three principal parts.

Essentially the clutch consists of a driving arm with gear, the driven member, and a set of three gripping cams mounted in a suitable carrier. As can be seen in Fig. 1, the driving arm is made of cast iron, and in its hub is keyed a hardened steel gear that oscillates freely on an extension of the driven shaft. Drive for the arm is usually through a crank or other mechanism producing reciprocating motion. The driven member is a chrome-nickel steel forging hardened and ground on its inner circumference, and has provision for pinning or keying its extended hub to the driven shaft through a shear pin. Three steel pins staked between two steel disks carry the three cam pieces which are milled from the solid, and are hardened, but not ground. On one side of each cam is a gear sector composed of three and a half teeth which engage the gear in the driving arm hub. The profile of the cam starts at the root of one tooth and ends at the top of another.

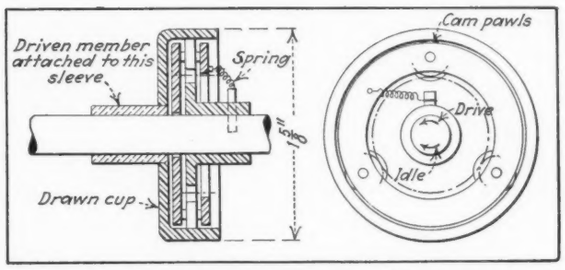


Fig. 2—Small Columbia Intermittent-Motion Clutch made out of pressed steel parts at low cost

In operation, the cams are self-locking in the driving direction, but release instantly as soon as the driving motion is reversed. Backlash is eliminated with the aid of a small coil spring connecting the driver arm with a pin in the outside planetary disk. This spring holds the cams in sliding contact with the race in the driven member under a very light pressure. Practically no movement is then required to lock the cams, making the entire device rotate through the required angle until released by a reversal of the driving motion. When in the locked position the disk pins carry no load as the sector teeth are designed to wedge on the driving gear teeth. For this reason a slight amount of play is allowed between the cam pieces and their journal pins. Similarly, in the idle position the whole cam assembly floats on the central gear. The clutch is immersed in an oil bath.

The unit pictured in Fig. 1 is about $9\frac{1}{2}$ in. in diameter. A much smaller size, Fig. 2, has also been built out of pressed steel parts, including the gears and cams, for driving the fan of a vacuum cleaner through the medium of the supporting wheels as they are rolled along the rug. The driving gear is pinned to the wheel axle, and a worm wheel for driving the fan is mounted on the driven hub. When the axle is reversed in direction of rotation, the fan idles in the forward direction. In this case the clutch is about $1\frac{5}{8}$ in. in diameter.

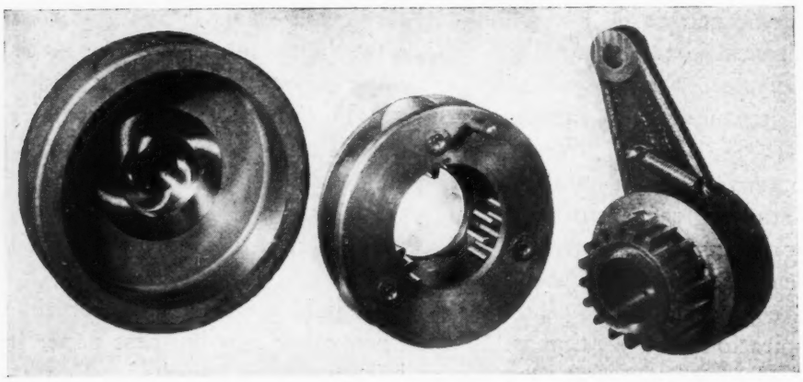


FIG. 1—COLUMBIA INTERMITTENT-MOTION CLUTCH
The three principal parts of the clutch, showing the three cams actuated by gear sectors engaging a central gear carried in the drive arm

"Konel" Heat-Resistant Alloy

DEVELOPMENT of an alloy known as "Konel," which is credited with being much stronger than other metals at high temperatures, and which can be used extensively in the moving parts of internal-cumbustion engines and in other extremely hot places, has been announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The announcement followed the granting of foreign patent rights.

Originally developed by the Westinghouse Research Laboratories as a substitute for platinum in the manu-

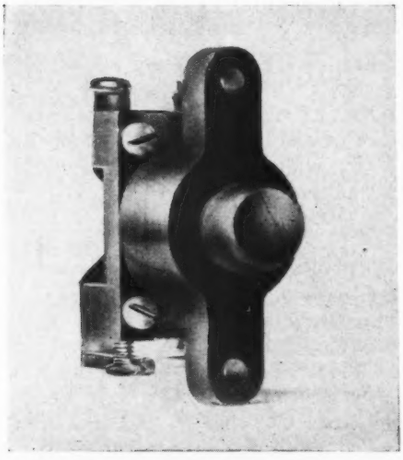
facture of filaments for radio tubes, Konel metal was discovered to be harder to forge than steel, and to be very tough at high temperatures, when most metals lose their strength. The composition is: nickel 70, cobalt, 20, and ferrotitanium, 10 per cent. Whereas platinum costs $65 an ounce, Konel costs only a few dollars a pound and the life of the material when used in radio filaments is approximately ten times as great as any other material.

The physical properties are as follows: Density, 8.59; average coefficient of expansion, from 0 to 100 deg. C., 10.75×10^{-6}, from 0 to 700 deg. C., 14.30×10^{-6}; specific resistance, micro-ohms per cm. at 1,000 deg. C., 108; at 600 deg. C., proportional limit, 23,000 lbs. per sq.in., yield point, 41,600 lbs. per sq.in., and ultimate strength, 66,000 lbs. per sq.in.; elongation in 2 in. at 600 deg. C., 18.5 per cent; reduction in area at 600 deg. C., 25.5 per cent. It work-hardens rapidly and needs frequent annealing at 900-1,000 deg. C., at which temperature range it shows little, if any, tendency to scale, and is still quite resistant to the hammer.

■

Westinghouse Push-Button Units

A PUSH-BUTTON unit is being offered by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., for use with machine tools, elevators, conveyors, and in other applications where a control station is desired as a built-in unit. The neat appearance and compactness of the push-button unit combined with the ease of mounting, the flexibility of arrangement, the time saved in wiring, and the low cost make it practical for industrial control applications.



FRONT VIEW of the Westinghouse Push-Button Unit, which is suitable for built-in applications

The unit is so designed that it may be conveniently used in groups on control stations. As the units may be mounted directly on the cover plate, wiring is greatly facilitated and the cost of installation reduced.

The frame, on which the mechanism is mounted, is of black Micarta. The operating button can be furnished in either black or red.

■

"Lusterite" No. 123 Stainless Vitreous Enamel

AFTER considerable research and experimentation, the Chicago Vitreous Enamel Product Company, 1407 South 55th Court, Cicero, Ill., has developed an acid-resisting, stainless enamel that is claimed to have none of the drawbacks of the earlier enamels. The temperature at which "Lusterite" No. 123 enamel will fuse is the same as now required for the average commercial cover coat. It has, in fact, an unusually broad burning range and, according to the manufacturer, will withstand severe over-firing without impairing its luster, texture, or quality. For this reason it is possible to use the enamel on thin-gage sheet metal without danger of warpage, such as would occur with high-temperature firing.

Lusterite No. 123 enamel may be applied in the same manner as commercial cover coats. It can be dipped, slushed, or sprayed with the same results as commercial enamels. It is an opaque frit, requiring only the normal amounts of tin oxide to produce an opacity equivalent to the enamels used today. When 6 parts of clay, 6 of tin oxide, and $\frac{1}{4}$ to $\frac{3}{8}$ of alum are added to 100 parts of the No. 123 frit, the mixture will remain in suspension in water for an indefinite period, when ground to the same degree as the average enamel. There is no tendency to settle out and form a hard sludge. The enamel will hold its position on vertical surfaces and will not run and cause an accumulation along the lower edge of the product. It has no tendency to develop crazing and strain lines and will not show black specks or a pitted surface. The thickness of No. 123 coating conforms to present practice, and the enamel may be used for both finish and half finish coats. This feature makes for economy in production.

The frit works as well in colors as it does in white. It is free from lead or lead oxide.

Results based on tests for cross bending or tensile strength, made according to Bureau of Standards methods, indicate that this acid-resisting enamel has from 25 to 45 per cent greater tensile strength than the average enamel now in use for finish coats. The enamel has been subjected to the common food acids, such as citric, malic, tartaric and lactic, as well as the less common ones, such as tannic, oxalic, acetic, benzoic, uric, and buteric, without developing any indications of acid attack. Acid-resisting enamel No. 123 is recommended by the manufacturer for such applications as refrigerators, cooking ranges, table tops, utensils and the like.

■

Cutler-Hammer Automatic Direct-Current Starter

A COUNTER E.M.F. type automatic starter for small d.c. motors has been announced by Cutler-Hammer, Inc., 80 Twelfth St., Milwaukee, Wis. This small motor starter has such features as reduced voltage starting, thermal overload protection,

Cutler Hammer Counter E.M.F. Type Automatic Starter for D.C. Small Motors

low-voltage protection, and renewable silver contacts. It is rated up to 2 hp. at 115 or 230 volts. The contactors are designed especially for d. c. service, and the renewable silver contacts insure long life. Each starter is supplied with a separate push-button master switch providing three-wire remote control. Two-wire control can be furnished, if desired.

The starter consists of a main line contactor, an accelerating contactor, an armature resistor, and the thermal

NEW MATERIALS AND PARTS

overload relays. On depressing the start button of the master switch the main line contactor connects the motor to the line through the armature resistor. As the motor accelerates to the proper point, the counter E.M.F. of the motor armature closes the accelerating contactor which cuts out the armature resistor, connecting the motor across the line. The standard starter is supplied with thermal overload relays, but starters without the relays are also available.

Actinized "Sumet" Bronze

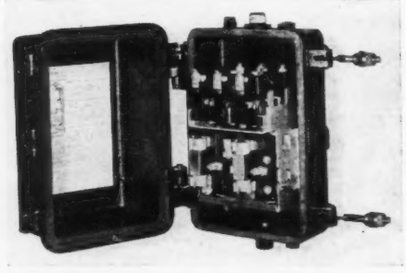
HIGH-LEAD bronze, in which by a special "Actinizing" process all internal strains, growth, and distortion have been eliminated, is being placed on the market by the Sumet Corporation, Buffalo, N. Y. The material is available in cored and solid bars, drawn rods, and in castings of all sizes, and can be had in soft, medium, and hard grades.

Actinized "Sumet" bronze is claimed to have a true homogeneous structure with the lead particles embedded in the matrix, thus combining the anti-frictional qualities of babbitt with the tensile strength of bronze. The lead cannot melt out under any operating condition, and the coefficient of friction is reduced to a minimum at high bearing temperatures because of the absolute uniformity of the structure.

■

Condit Types A-20 and A-30 Across-the-Line Starters

THE Condit Electrical Manufacturing Corporation, Boston, Mass., has announced the development of a gas-tight inclosing case for its across-the-line motor starters, Types A-20 and A-30. The inclosing case is of cast-iron construction. A gasket is provided between the cover and the case. Four heavy eye-bolts and nuts hold the cover, which is hinged and has provision for padlocking. Provision is also made for conduit connections at the top and the bottom. In addition to being gas-tight, the inclosing case is dust-tight and weather-proof.



A Gas-Tight Inclosing Case has been applied to the Condit Types A-20 and A-30 Across-the-Line Starters

The inclosing case is offered for installation in mines, woodworking plants, cement mills, flour mills, pulverizing plants, chemical plants, and other industries where a large amount of dust or gas may interfere with the efficient operation of a standard starter.

■

"Tempaloy," a Hardenable Copper Alloy

A HARDENABLE copper alloy, known as "Tempaloy," has been developed by The American Brass Company, Waterbury, Conn. Tempaloy has the approximate composition of 95 per cent copper, 4 per cent nickel, and 1 per cent silicon. When heated to 750 to 800 deg. C., the nickel silicide goes into solid solution and, if chilled from this temperature, the alloy is soft and ductile. When heat-treated at approximately 450 deg. C. for several hours, the nickel silicide is precipitated and the material becomes hard and strong, resembling mild steel in its physical properties. The reaction is similar to that which takes place in hardening Duralumin by heat-treatment or ageing.

Tempaloy rod $\frac{9}{16}$ in. in diameter, after cold drawing, had a tensile strength of 71,200 lb. per sq.in. and a Brinell hardness of 133 (1,000-kg. load, 10-mm. ball). After heat-treatment the tensile strength was 113,800 lb. per sq.in. and the Brinell hardness 204.

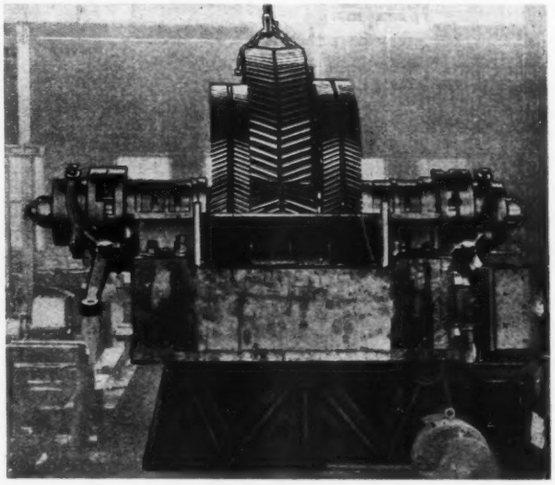
The addition of aluminum to this alloy strengthens it considerably and accentuates the hardening properties. Tempaloy to which 5 per cent aluminum has been added has a yield point of 25,000 lb. per sq.in. and a tensile strength of 65,000 lb. per sq.in. after quenching from 800 deg. C. When heat-treated at 450 deg. C., the yield point is 100,000 lb. per sq.in. and the tensile strength 130,000 lb. per sq.in. The addition of larger amounts of aluminum to this alloy has resulted in a material having a tensile strength of 150,000 lb. per sq. inch.

■

Gears & Forgings Two-Speed Mill Drive

A TWO-SPEED mill drive has been built by Gears & Forgings, Inc., Cleveland, Ohio. One of these units is now driving a slabbing mill. A feature of this unit is that no clutch parts are located inside of the drive. The clutch is external, attached to the intermediate shaft. This permits the use of a comparatively narrow and rigid gear drive.

The prime mover is a 1,000-hp. motor of 445 to 590 r.p.m. The mill itself has a speed of 9.01 to 11.94 r.p.m. through one set of gears and 12.01 to 15.93 r.p.m. through the second set of gears. The overall dimensions of the drive are 26 ft. long by 17 ft. wide. The total weight is 350,000 pounds.



GEARS & FORGINGS Two-Speed Mill Drive

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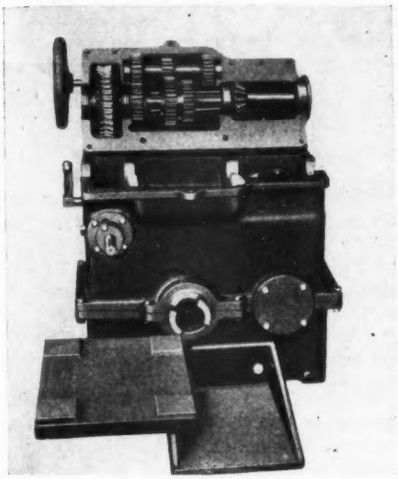
Gears & Forgings Stoker Drive

A THREE-SPEED reducer, recently developed by Gears & Forgings, Inc., Cleveland, Ohio, has been applied to automatic stoker drives. The change of speeds is accomplished by a handwheel operating a threaded shaft, upon which the shifting fork

NEW MATERIALS AND PARTS



GEARS & FORGINGS
Three-Speed Stoker Drive

is mounted. This wheel, easily accessible to the operator, enables him to regulate the amount of coal fed to the boiler by merely changing the speed of the drive unit.

The change gearbox has a splined shaft, which is an extension of the worm gear shaft, and which is mounted on two sets of Timken roller bearings, and also a jackshaft upon which two sets of change gears are mounted. The sliding gears on the splined shaft engage either one of these change gears, or by means of a clutch engage the gear mounted on the wormgear shaft.

The housing is of semi-steel, and consists of three sections split horizontally, but bolted together. All change gears, bevel gears, and worms are of carburized steel to minimize wear.

REVIEW OF RECENT PATENTS

Parts and Mechanisms

The combination in a lathe cross-feed of a high speed shaft, a clutch for engaging the shaft, means for opening the clutch automatically, and means for further manual operation, is the subject of patent 1,728,220 assigned to the R. K. Le Blond Machine Tool Company.

A flexible gear drive having radius rods connecting a flange member and spring means for driving a gear member is the subject of patent 1,728,401 assigned to Geo. A. Chritton of Chicago, Illinois.

Roy H. Smith of Kent, Ohio, has been granted patent 1,731,355 on a stock-cutting mechanism that comprises a reciprocating slide carrying a cutter, and means for actuating the slide in both directions.

A multi-plate drive chain is the subject of patent 1,727,129 assigned to the Morse Chain Co. The patent covers a chain with snap means for holding plate links in predetermined relations, said means being yielding under positive pressures.

To the Ontario Silver Co. has been assigned patent 1,726,577 relating to a feed and discharge mechanism for presses and including a reciprocating member recessed for receiving and gripping blanks and for releasing same during the idle stroke.

Patent 1,726,698, assigned to the Paper & Textile Machinery Co., covers a mold for centrifugal casting machines, comprising a rotor, a liner in spaced relation therein and means for delivering a cooling fluid to the space between the liner and the rotor.

The Timken Roller Bearing Co. is assignee of patent 1,727,576 on a roller bearing having headless rollers arranged to contact endwise against a thrust rib, one of the contacting surfaces being convexly curved in longitudinal section.

Materials

An alloy containing 40 to 90 per cent of vanadium, 3 to 15 per cent of aluminum, 5 to 30 per cent of silicon, and the remainder principally iron, is the subject of patent 1,727,180, assigned to the Vanadium Corporation of America.

To the Bakelite Corporation has been assigned patent 1,728,378 on a molding mixture of phenolic resin composition including agent, a filling material, and an aldehyde having a boiling point above 100 deg. Centigrade.

The Carbide and Carbon Chemicals Corporation has been assigned patent 1,731,333 on a thinner for pyroxylin lacquers, comprising about 30 per cent of ethyl acetate and ethyl alcohol, not more than 20 per cent of monoethyl ether of ethylene glycol and the acetate of monoethyl ether of ethylene glycol, and the remainder a suitable hydrocarbon solvent.

A bearing metal alloy comprising about 70 to 75 per cent of lead, about 15 to 25 per cent of antimony, about 3 to 6 per cent of tin, about 1 to 3 per cent of a metal of the cobalt type, about 0.6 to 2 per cent of copper, and an appreciable amount, not exceeding 1 per cent, of metals of the iron group, is the subject of patent 1,731,021, granted to Karl Müller, and Wilhelm Sander, of Essen, Germany.

A resistance alloy containing at least 60 per cent of chromium and at least 40 per cent of tungsten is the subject of patent 1,731,267, assigned to the Westinghouse Lamp Company.

PUBLICATIONS

A.S.T.M. Standards. The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., has published an "Index to A.S.T.M. Standards and Tentative Standards" as of September 3, 1929. This yearly publication contains references to the standards which have been formally approved. The index is designed to be of service in locating any specifications or tests in the bound publication in which it appears, and aids those interested in ascertaining if the Society has issued any standards on specific subjects. A complete list of the various committees is given also.

Ball Bearing Data Sheets. The New Departure Manufacturing Co., Bristol, Conn., has published revisions of several pages of the F. E. edition of the "New Departure Engineering Handbook." Included also are a new bulletin No. 191 F.E., and a revised table of contents.

Blue Printing Machines. The Shaw Blue Print Machine Co., Inc., Newark, N. J., has published "The Most Modern Blue Printer" which shows an improved lamp, a horizontal blue printing machine, a wringer and dryer, and an upright machine. Technical data on these products are also included. The bulletin contains eight 11½x8½-in. pages.

Welded Chains. The U. S. Department of Commerce, Bureau of Standards, has issued simplified practice recommendation R100-29, which proposes to eliminate various sizes of the various types of chains. The recommendation covers 12 pages and may be obtained through the U. S. Government Printing Office, Washington, D. C., for ten cents a single copy.

Electric Control Apparatus. The Allen-Bradley Co., Milwaukee, Wis., has published a large group of publications for insertion in the standard binder. The subjects are: d.c. manual starters, a.c. automatic starters, d.c. and a.c. mill and crane controllers, d.c. and a.c. rheostats, battery charging and testing equipment, a.c. manual starters, a.c. automatic starters, and accessories. Each bulletin contains complete technical information and prices. The sheets are 11 x 8½ inches.

✦ WHAT'S GOING ON ✦

Cylinder Multiplication Is Auto Show Trend

BY HERBERT CHASE

NOT so much "bigger and better" cylinders, as more of them, were in evidence at the annual New York Automobile Show, although trends in both directions were traceable. Efforts to obtain more power as well as greater smoothness in operation are the engineering reasons back of this tendency, but the commercial reason is that eights are inclined to sell more readily to a public educated into believing that the number of cylinders is at least one measure of value.

Four-speed gearsets, specially designed for quieter operation; cleaner and simpler brake layouts with cables replacing rods in many cases; refinements in steering systems, intended to bring easier steering, to cushion road shocks, and to stop wheel wabble; general increase in cushion mounting of the engine to prevent the transmission of vibration to the body; wider use of crankcase ventilating systems discharging below the car; decreased use of transmission brakes; further increase in the use of chromium plating and stainless steel for exposed bright-work; and general refinement in body design, are among the noteworthy features of special interest to engineers.

Cadillac's 16-cylinder powerplant and the Cord and Ruxton front-wheel drive cars naturally were the centers of much interest because of their comparative novelty. Gardner also presented an eight-cylinder front-wheel drive car, but it was not in the show itself. More nearly conventional high spots were the new eights shown by Dodge, Hudson, Oakland, De Soto, Marmon, Hupmobile, Graham, Peerless, and several other makers; the Erskine six, because of its powerful engine and low price; the new Willys, Dodge, and Essex sixes; and the completely redesigned Franklin six with its side-draft air-cooling arrangement and aluminum head.

All the new engines with eight or more cylinders are in-line types, with the exception of the two new General Motors products, Oakland and Cadillac, which adhere to the "V" arrangement. Incidentally, the new Cadillac has overhead valves with an automatic clearance take-up to assure silent operation.

Down-draft carbureters and inlet manifolds are seen on many engines and thermostats are more widely used than formerly for control of engine temperature. Hupmobiles have a section of the radiator partitioned off for oil cooling, and many makers provide external oil filters.

PRESENT STYLES call for lower and roomier bodies as well as for high and narrow hoods. The latter have a variety of louver arrangements and often incorporate raised panels for decorative effect. Black japanned fenders are giving place to those finished in lacquer to match bodies. Most windshields are tilted and have quick-adjusting devices and often chromium-plated frames. Exterior visors are narrow, and are usually arched and sometimes peaked to conform with other body lines. Some adjustable interior visors also are furnished.

MOST OPEN cars continue to be of the "sport" type, finished in striking colors with an abundance of chromium trim. Convertible bodies are increasingly popular. They are provided with glass panels that lower into doors and seat backs, and can be left up to serve as windscreens when the top is down. Adjustable front seats are common and in some cases rear seats also are adjustable.

Many bodies made in large quantities are of pressed steel throughout, but the majority of makers still adhere to composite wood and metal types, with wire mesh support for roof decks gaining in favor. Molded-on rubber coverings for running boards are common and floor boards with a similar covering have made their appearance. Steel rather than wood is the favored material for running boards.

In general, the new models show a trend toward greater power and speed, finer appearance, greater comfort, and easier operation.

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The Month In Product Design

AMONG the new models of electrical products announced during January, according to *Electrical Merchandising*, is a new line of Kelvinator household refrigerators with an outstanding feature of silent operation obtained by redesign for extreme accuracy of the moving parts. It is claimed that a variation of more than 0.0002 in. is not permitted in the important elements. The new finishes include Chinese red with parrot designs, French gray trims, Jersey cream with colored designs, and also apple green. The Bryant Electric Refrigerator Corporation is also getting out a new design of electric refrigerator, using anhydrous sulphur dioxide as the refrigerant.

An electric floor polisher put on the market by the A. S. Boyle Company has a universal motor with a speed of 7,500 r.p.m., geared to the brush on a 5 to 1 ratio. The motor housing is made of two aluminum die castings. Cadmium plating is used on the steel parts.

That bright finishes for household products continue in vogue is indicated by the announcement of a new line of electric ranges by the Roberts & Mander Stove Company. Finishes are green, buff, and ivory. The stove form is conventional, the chief new features of design being Chromalox inclosed heating units, load balance switches, and the absence of exposed bolts and nuts. In the new design of electric washer put out by the General Utilities Manufacturing Company, the entire tub is of Monel metal, and the steel parts of the wringer are chromium plated.

A new design of outboard motor for boats, announced by the Johnson Motor

Company, weighs only 27 pounds for the single, 3-port type. It has detachable aluminum cylinder heads, an automobile-type carburetor, and no exposed moving parts.

A plane designed for commercial service, as well as to meet the rigid requirements of the Guggenheim competition, was awarded first prize in that contest recently. It is a cabin-type biplane built by the Curtiss Airplane & Motor Corporation, called the Curtis Manager. It is powered with a Curtiss Challenger air-cooled engine. A crank and sprocket arrangement operated by the pilot controls the wing flaps, which are placed where the ailerons are on the ordinary machine. Wing slots are also a feature.

The Army Air Corps has developed a camera, utilizing the infra-red ray, which uses an emulsion so sensitive and rapid that an exposure of one-fiftieth of a second is sufficient. The camera is capable of taking pictures of objects at a distance of 225 miles, and vertical pictures through clouds at 5 miles with such distinctness that images of men walking on the street appear.

Two 4-cu.yd. concrete mixers, built by Norris K. Davis, to be used on the new Owyhee dam, are unusual because of the difficulties of construction resulting from their size. The drums are 110 in. in diameter inside, and 13 ft. long, with a shell of $\frac{3}{8}$-in. steel and a liner of the same thickness. Except where the shell is riveted to the center ring, it is of welded construction. The entire inside surface, including vanes, is surfaced with Davis process steel surfacing applied by electric welding. Tilting for discharge is done by a 19-in. cushioned air cylinder, the maximum tilt being 66 deg. The tilting portion is balanced at all points of the tilt, the cylinder being used only to allow for the concrete. A cast-iron ring, $4\frac{1}{2}$ in. thick by 18 in. wide, weighing 5 tons, carries the weight of the drum, and is toothed to permit drive from a 100-hp. motor. Motor speed is 575 r.p.m., 440 volts, and the drum speed is 10 revolutions per min. The charging hopper is separate.

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Tentative Lettering Standard Now Being Distributed for Criticism

A TENTATIVE form on lettering, a section of the American Recommended Practice for Drawings and Drafting Room Practice, and third in the series, is being distributed at the present time for criticism and comment. This standard is being developed under the procedure of the American Standards Association and is jointly sponsored by the Society for the Promotion of Engineering Education and the American Society of Mechanical Engineers.

Outstanding among the recommendations is the one that vertical letters, instead of the sloped letter forms formerly advocated should be generally adopted. This recommendation is made because a great many of the larger concerns are now using the vertical letter, having found that it is the form which tracers can make most legibly. As in script, sloped letters invariably carry personal characteristics of the letterer, a feature which is not so noticeable with the vertical letter.

TYPE 1
ABCDEFGHIJKLMNOP
QRSTUVWXYZ &
1234567890 3" 7"/64 16
TO BE USED FOR MAIN
TITLES & DRAWING NUMBERS

TYPE 2
A B C D E F G H I J K L M N O P
Q R S T U V W X Y Z &
1 2 3 4 5 6 7 8 9 0 3" 7"/64 16
FOR HEADINGS AND PROMINENT NOTES

TYPE 3
A B C D E F G H I J K L M N O P Q R S
T U V W X Y Z &
1 2 3 4 5 6 7 8 9 0 3" 7"/64 16
FOR BILLS OF MATERIAL DIMENSIONS & GENERAL NOTES.

ALL FRACTION LINES MUST BE HORIZONTAL.

TYPE 4
OPTIONAL TYPE FOR TITLES AND NOTES MAY BE USED ON THE BODY OF DRAWINGS SAME AS TYPE 3, BUT USING LARGER CAPITALS OF TYPE 2 FOR PRINCIPAL WORDS.

NOTE:
THE ABOVE SIZES OF LETTERING ARE RECOMMENDED FOR DIRECT PRINTING TRACINGS

The recommendations include: That vertical caps, vertical caps and small caps, and vertical lower case letters, also in titles, sub-titles, notes, and part lists, should be used. The size of lettering should not be graded according to the size of the drawing unless photographic prints are to be made. In other work, the size of the lettering should be such as will produce legible prints. When letters are machine printed Gothic lettering should be used. Lettering guides or templates, style of pens, and similar items are at the discretion of the user, but should be selected to obtain results in keeping with the recommended lettering practice. Copies of the suggested standard may be obtained.

News of the Metal Markets

A LARGE aluminum foundry is being built on the Dnieper River, to have an annual production of 100,000 tons of aluminum. Russian bauxite, reduced at the Viborg works, will be used. No effect, one way or another, on the American supplies of the metal is anticipated from the enterprise. Consumption of aluminum by the American motor industry was increased substantially in 1929, as compared with 1928, while large tonnages were taken by household-appliance manufacturers, and the radio, aircraft, and electrical-manufacturing industries. A new use of aluminum which promises to take substantial tonnages in the future, is in the manufacture of furniture. The great future outlet for aluminum, particularly in the form of strong alloys, appears to lie in the general transportation field, including motor, rail, air, and water transport.

WITH NEW SUPPLIES of tin discovered in Spain, there is a plentiful future supply of this important "strategic" metal, which is so necessary for bearing bronzes and plate coverings. The London correspondent of the *Engineering & Mining* Journal reports that Nigerian producers scarcely count nowadays and that many production difficulties exist among Malayan and Banka producers. A huge merger has been announced in London of four of the largest British-owned companies. The recent recommendations of the Tin Producers' Association of London for the curtailment of tin production in an effort to stabilize the industry will cut tin deliveries in 1930 between 7 and 9 per cent under deliveries for 1928, 1929 figures not yet being available.

COPPER PRICES have remained quiet at about 18 cents a pound. The movement in fabricated copper indicates, says *Mining Journal*, that the consumers feel that the price is going to continue firm during the early part of 1930, at least. The prices of rolled metals, copper, lead, zinc, Monel metal, and nickel have remained unchanged since early December. If the present low prices of silver, which have reached almost the lowest ever recorded, continue, this metal may come into wider commercial use, especially for general commercial parts plating.

ZINC PRICES have not descended to such a low figure in 20 years as in November London quotations, but just at present there is a good demand for zinc, with customers willing to book ahead for six months. Few sellers, however, were quoting that far in the future, indicating that a rise in prices may be expected. Other metals are showing but little tendency to change in price to any extent at any time in the near future. Continued drops in silver prices will make this metal a more common plating medium.

✦ IN THE SPOTLIGHT ✦

J. J. HARTLEY has been appointed chief engineer of the Pershing Road plant, Chicago, of the Link-Belt Co. He was formerly in charge of foundry equipment sales in the western division of the Link-Belt organization. For the past 19 years he has held various positions, including considerable practical experience in addition to his engineering work.

MISS MARGARET INGELS, first woman to receive a degree in mechanical engineering from the University of Kentucky and former research engineer for the American Society of Heating & Ventilating Engineers and the State of New York, has joined the Carrier-Lyle Corporation, Newark, N. J., as an engineer specializing in the development and use of air-conditioning devices.

DR. ELMER A. SPERRY, past president of the A.S.M.E., was elected an honorary life member of the Engineering Association of Hawaii during his recent visit to the island on his return from the World Engineering Congress.

E. R. WEBER, formerly assistant chief engineer of the R. D. Nuttal division of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has resigned to become chief engineer of the Thomas Spacing Machine Co., Pittsburgh.

DR. MAURICE J. ZUCROW, graduate of the Harvard Engineering School and former research associate in carburetor work at Purdue University, has joined the Paragon Vaporizer Corporation, Chicago, as research engineer.

H. D. MATTHEWS, formerly section engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has been made consulting engineer for the W. M. Chace Valve Co., Detroit.

WILLIAM MCPHERSON, dean of the graduate school of Ohio State University, Columbus, Ohio, became president of the American Chemical Society on Jan. 1. He succeeded as president, Dr. Irving Langmuir, associate director of research of the General Electric Company.

OPIE CHENOWETH, formerly mechanical engineer of the Material Division of the Air Corps, at Wright Field, Dayton, Ohio, has become research engineer at the General Motors Laboratories. He is a graduate of Purdue University.

KENNETH R. HERMAN, assistant engineer of the DivCo-Detroit Corporation, Detroit, Mich., has been promoted to chief engineer.

J. TRANTIN, JR., has become metallurgical engineer for the Fort Pitt Steel Casting Co., McKeesport, Pa. He was graduated from the University of Wisconsin in 1915 and has served as metallographist for the Illinois Steel Co., as research engineer for the Western Electric Co., industrial engineer for L. V. Estes, Inc., and chief metallurgist and director of research for the Pettibone-Mulliken Company.

MARGARET INGELS

J. J. HARTLEY

ERWIN E. DREESE

ERWIN E. DRESSE, chief engineer for the past year of the Lincoln Electric Co., Cleveland, has been appointed professor of electrical engineering at Ohio State University, Columbus, Ohio.

BENJAMIN G. PARSONS, formerly chief engineer of the Hurricane Motor Co., Houston, Texas, has assumed a similar position with the Hurricane Aviation Corporation, also of Houston.

CHARLES F. SCOTT, New Haven, Conn., was recently awarded the Edison Medal of the A.I.E.E. "for his contributions to the science and art of polyphase transmission of electrical energy." Mr. Scott is professor of electrical engineering at Yale University, and was for seven years consulting engineer for the Westinghouse Company.

FRANK W. FUNK has been appointed managing engineer of the Jackson, Mich., division of Stevens & Wood, New York City.

WALLACE S. OLIVER has been made chief engineer of the Hydraulic Brake Co. His previous post was assistant chief engineer.

HARRY R. NELSON, formerly with the Charles L. Anderson Machinery Co., Chicago, is now connected with the Tool Equipment Sales Co., Chicago, as mechanical engineer.

A. A. WARNER has been made chief engineer of the Universal Products Co., Dearborn, Michigan.

FREDERICK O. BALL, formerly president and general manager of the Ball & Ball Carburetor Co., Detroit, Mich., has become a research engineer for the Chrysler Corporation, Detroit.

RAY M. HUDSON, assistant director of the National Bureau of Standards in charge of commercial standardization, resigned, effective Dec. 31, to assume new duties as secretary of the Massachusetts division of the New England Council with headquarters in Boston.

WILLIAM S. LEE, vice-president and chief engineer of the Duke Power Co., Charlotte, N. C., has been nominated president of the A.I.E.E. He will be voted upon at the coming election in the spring. Since but one nomination is made, his election is virtually assured.

DR. LEE DEFOREST, inventor of the three-element vacuum tube, was recently elected president of the Institute of Radio Engineers. Colonel A. G. Lee, radio engineer attached to the British Post Office, was elected vice-president.

EDWARD P. WARNER, editor of *Aviation* and former assistant secretary of the U. S. Navy for aeronautics, was elected president of the S.A.E. recently.

HAROLD T. YOUNGREN has resigned as executive engineer of the Studebaker Corporation of America to become assistant chief engineer of the Buick Motor Co., Flint, Michigan.

GEORGE B. ALLEN, formerly chief engineer of the Dodge Brothers Corporation, Detroit factory, has been promoted to director of engineering.

HARRY A. SCHWARTZ, manager of research, National Malleable & Steel Castings Co., Cleveland, has been selected to receive the 1930 major award of the American Foundrymen's Asso-

ciation, the John A. Penton gold medal. He is especially noted for his researches on malleable iron and is at present chairman of two important committees of the malleable division.

L. R. Nourie, Park building, Pittsburgh, has been appointed district engineer for northern West Virginia, eastern Ohio, western Pennsylvania, and Allegheny and Garrett counties in Maryland for the Despatch Oven Co., Minneapolis.

Albert H. Maggs, formerly designing engineer with the Ahrens-Fox Fire Engine Co., Cincinnati, has been made assistant chief engineer.

Thomas Backus, formerly engineer for the Willys-Overland Co., Toledo, is now designer for the Caterpillar Tractor Co., San Leandro, California.

Ronald M. Hazen has been appointed assistant chief engineer of the Fairchild Engine Corporation, Farmingdale, New York.

Mrs. Lilliam M. Gilbreth, only woman delegate to the World Engineering Congress at Tokyo, manager of Gilbreth, Inc., Montclair, N. J., and mother of 11 children, will be the principal speaker at the "Ladies Night" observance of the A.S.M.E. on Jan. 20 in New York.

E. J. Bonneson has been appointed field engineer of the American Telephone & Telegraph Co., in the St. Louis area, replacing H. W. Nyland, who is now in New York on special assignment work.

Gustave Chutorash, formerly assistant to the body engineer, Fisher Body Corporation, Detroit, has been advanced to chief engineer.

W. C. Mackenzie has been appointed chief engineer of the Standard Motor Truck Co., Detroit.

Thorsten Y. Olsen, formerly vice-president, has succeeded his father as president of the Tinius Olsen Testing Machine Co., Philadelphia. The younger Mr. Olsen is a Cornell graduate, and was elected vice-president in 1912. Tinius Olsen is now in his 84th year.

E. B. Nichols, formerly with the Bell Telephone Laboratories, has been appointed chief engineer of the Brown Instrument Co., Philadelphia, Pa. Mr. Nichols was at one time chief engineer of the Pfaudler Co., and later of the Victor Talking Machine Co. He will act in an administrative capacity, supervising the work of the engineering staff.

Courtney Mitchell has become chief engineer of the Door Check Manufacturing Co., Cleveland, Ohio.

Arthur J. Hazen, formerly chief draftsman of the Kissell Motor Car Co., Detroit, has been made assistant chief engineer.

L. Warrington Chubb, manager of the radio engineering department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has been appointed first assistant to the vice-president in charge of engineering of the new Radio-Victor Corporation of America. His headquarters will be in Camden, N. J. He is a graduate of Ohio State University.

Richard W. Hautzenroeder, until recently designer and assistant to the chief engineer of the W. A. Riddell Co., Bucyrus, Ohio, has been promoted to chief designer of the crawler engineering department.

John G. Allen, chief mechanical engineer at the New Castle works of the Carnegie Steel Co., has been appointed assistant general superintendent of the New Castle works.

LILLIAN GILBRETH

THORSTEN Y. OLSEN

L. WARRINGTON CHUBB

Meetings

Society of Automotive Engineers—Annual meeting, Jan. 20-24, Book-Cadillac Hotel, Detroit, Mich. C. F. Clarkson, 29 West 39th St., New York City, secretary.

Amercan Institute of Electrical Engineers — Winter convention, Jan. 27-31, New York City. Headquarters, Engineering Societies Bldg., 29 West 39th Street.

American Society for Steel Treating—Semi-annual meeting, Hotel Pennsylvania, New York City, Feb. 7-8. W. H. Eisenmann, 7016 Euclid Ave., Cleveland, Ohio, secretary.

Engineering Institute of Canada —Annual meeting, Feb. 12-14. R. J. Durley, 2050 Mansfield St., Montreal, Que., secretary.

American Institute of Mining & Metallurgical Engineers — Annual meeting, Feb. 17-20, New York City. H. Foster Bain, 29 West 39th St., secretary.

American Society of Mechanical Engineers—Fiftieth Anniversary celebration. Opens in New York, April 5, afternoon in Hoboken; April 6 in New York; April 7, 8, and 9 in Washington, D. C., at the Mayflower Hotel. Calvin W. Rice, 29 West 39th St., New York City, secretary.

Obituaries

John Morrison Hansen, president and chairman of the board of directors of the Standard Steel Car Co., Pittsburgh, died on Dec. 13 in La Rochelle, France. Mr. Hansen is said to have been designer of the first steel freight and passenger cars to be used in this country. He was born in Butler County, Pa., and had been a resident of the Pittsburgh district all his life. He was a graduate of the Western University of Pennsylvania and formerly was chief engineer of the Pressed Steel Car Company.

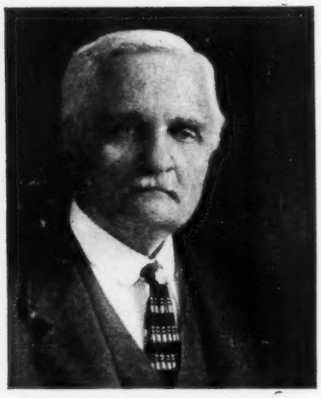
William Paton Thomson, New York, widely known engineer, died in the Atlantic City Hospital on Dec. 21, after an illness of several months. He was 57 years of age. He graduated from Princeton University in 1896 and had devoted most of his time since 1906 to railroad track work. His last work was with the Rail Joint Co., of which he was vice-president.

Wilhelm Maybach, 84, last of the three German pioneers in automobile construction, died in Stuttgart, Germany, on Dec. 30. He was the inventor of the spray carburetor, honeycomb radiator, and change-speed gear.

Dr. J. H. Rogers, 79, inventor of the multiplex telegraph printing machines and pioneer in underground and underwater radio communication, died in his home in Hyattsville, Md., on Decem-

ber 12. He has more than fifty important inventions, the majority of which were of a telegraphic or telephonic character. He won special recognition during the World War by devising means for successful communication with submarines.

WILFRED LEWIS, engineer and president of the Tabor Manufacturing Co., Philadelphia, until his retirement a year ago, died off the coast of Egypt recently



He was 75 years of age, and was an expert on gear mechanics and credited with being one of the world's gear authorities. He received an A.S.M.E. gold medal in 1927 for his achievements.

FRED D. HOLDSWORTH, engineer in charge of air compressor design at the Claremont, N. H., plant of the Sullivan Machinery Co., 400 North Michigan Ave., Chicago, from 1900 to 1928, died on Nov. 29. He was born in Wales, Mass., in 1867 and was graduated from Worcester Polytechnic Institute in 1888. After experience as a mechanical engineer with the Rhode Island Locomotive Works and with the G. F. Blake Co., afterward Blake & Knowles, he became affiliated with the Sullivan staff in 1900. He retired about a year ago, after having developed several types of air compressors and having been awarded almost 50 patents connected with various machines built by the company.

JOHN DUDLEY BIRD, 61, designer and builder of the first high-speed Corliss engine, and a noted engineer, died in his home in Milwaukee on Dec. 8. His connections as a mechanical engineer were numerous and varied.

ELLIOT J. BROWN, chief engineer for the past 25 years of the Washburn Wire Co., Philadelphia, died suddenly on Dec. 17. He had been chief engineer of plants located at Altoona, Pa., and New Haven, Conn. He was a graduate of Juniata College, and was 58 years of age.

MAJOR JAMES F. CASE, 61, head of the Paris office of Stone & Webster, Boston, and an engineer of international repute, died on Dec. 14 at the Hotel Grosvenor, New York City. He was graduated from the University of Wisconsin in 1890.

GEORGE S. AVEYARD, 55, recently retired secretary of the Jardine Engineering Corporation, Ltd., of China, Shanghai, died recently.

GEORGE F. W. POGGENBURG, 51, died on Dec. 17 at his home in Pelham, N. Y. He was an engineer and had for many years been associated with the automobile industry.

W. B. HOLLINGSHEAD, 81, who is claimed by his friends to be the original inventor of the disk phonograph record, died on Dec. 25 at his home in East Chester, New York.

JOSEPH H. NICHOLS, 63, formerly chief engineer of the Pierce-Arrow Motor Car Co., died in Buffalo, N. Y., recently.

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Engineers Wanted For Army Reserve Work

By GEORGE S. BRADY

Lt. Colonel, Ordnance Reserve Corps

MORE than 3,000 vacancies occurred at the beginning of 1930 in the procurement service of the U. S. Army Officers' Reserve Corps, of which about 1,900 vacancies are in the Ordnance Department, where qualified engineers with a knowledge of the design and manufacture of all kinds of products are wanted. As time elapses from the date of the World War, the supply of reserve officers with war experience available for procurement duty becomes more and more limited, and it is necessary to call on the younger generation of engineers to take up this duty.

Engineers who feel qualified for this work and who are willing to give the small amount of time necessary for study and training required each year, should write to the War Department office of the Chief of Ordnance, Washington, D. C., or to the nearest district office. Many types of men are needed in the procurement planning service for the work being done under the National Defense Act. It is not generally known that more than 35,000 separate complete articles are required for an army in the field. Each of the seven supply branches of the Army has established buying offices in various cities of the country, and it is largely to these offices that reserve officers are attached for training as inspectors, research specialists, industrial engineers, product specialists, and purchasing officers. The intention is to assign only men who are qualified for high-grade duty, and to keep the service on a high plane that can cooperate intelligently with industry.

General Motors Assigns Engineers to Foreign Posts

Following the transportation school held recently at Pontiac, Mich., the General Motors Export Co. has sent 13 engineers abroad. These engineers will be loaned free of charge to anyone with a commercial transportation problem, regardless of whether or not the inquirer intends to purchase General Motors products. Their work will be directly in consulting and advisory capacities in design, engineering, and transportation problems. The engineers and their assignments are as follows: Ira Snead, Batavia, Java; W. H. Smith, Alexandria, Egypt; H. L. Powell, Sao Paulo, Brazil; D. W. Nugent, Warsaw, Poland; H. G. Magginetti, Bombay, India; D. D. Wood, Port Elizabeth, South Africa; J. D. Morello, Madrid, Spain; A. L. Schoff, Osaka, Japan; A. Colligon, Antwerp, Belgium; O. L. Lindstrom, Stockholm, Sweden; L. S. Challe, Paris, France; J. Coates, Wellington, New Zealand; and T. Timm, Copenhagen, Denmark.

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Westinghouse to Build $1,500,000 Laboratory

A central engineering laboratory and an addition to the present d.c. power laboratory will be built by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., according to an announcement by F. A. Merrick, president. The new laboratory will eventually replace numerous smaller laboratories and experimental test stations now scattered throughout the plant, and will also provide many additional facilities. Six upper floors of the building will be used for engineering offices, and the remaining floors will house miscellaneous experimental work. The d.c.-laboratory and the first floor of the taller building will have head-room of more than 20 ft., and will be provided with crane facilities for handling 15-ton loads. Work has already been started on the structure, an 11-story building, 90x225 ft. Adjacent to this building will be the 125-ft. extension to the d.c.-laboratory.

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American Engineers Engaged for Soviets

Several score American engineers and foremen have recently been engaged to work for Soviet industrial and agricultural organizations. Twenty-three mechanics, engaged by the Zernotrest (State Grain Trust) to instruct Soviet workers in the use of combines and heavy tractors left recently, and 26 more are expected to sail shortly. Included are experts in the metal industry, construction, irrigation, mining, and similar work.

Capacity and Deflection of Helical Springs

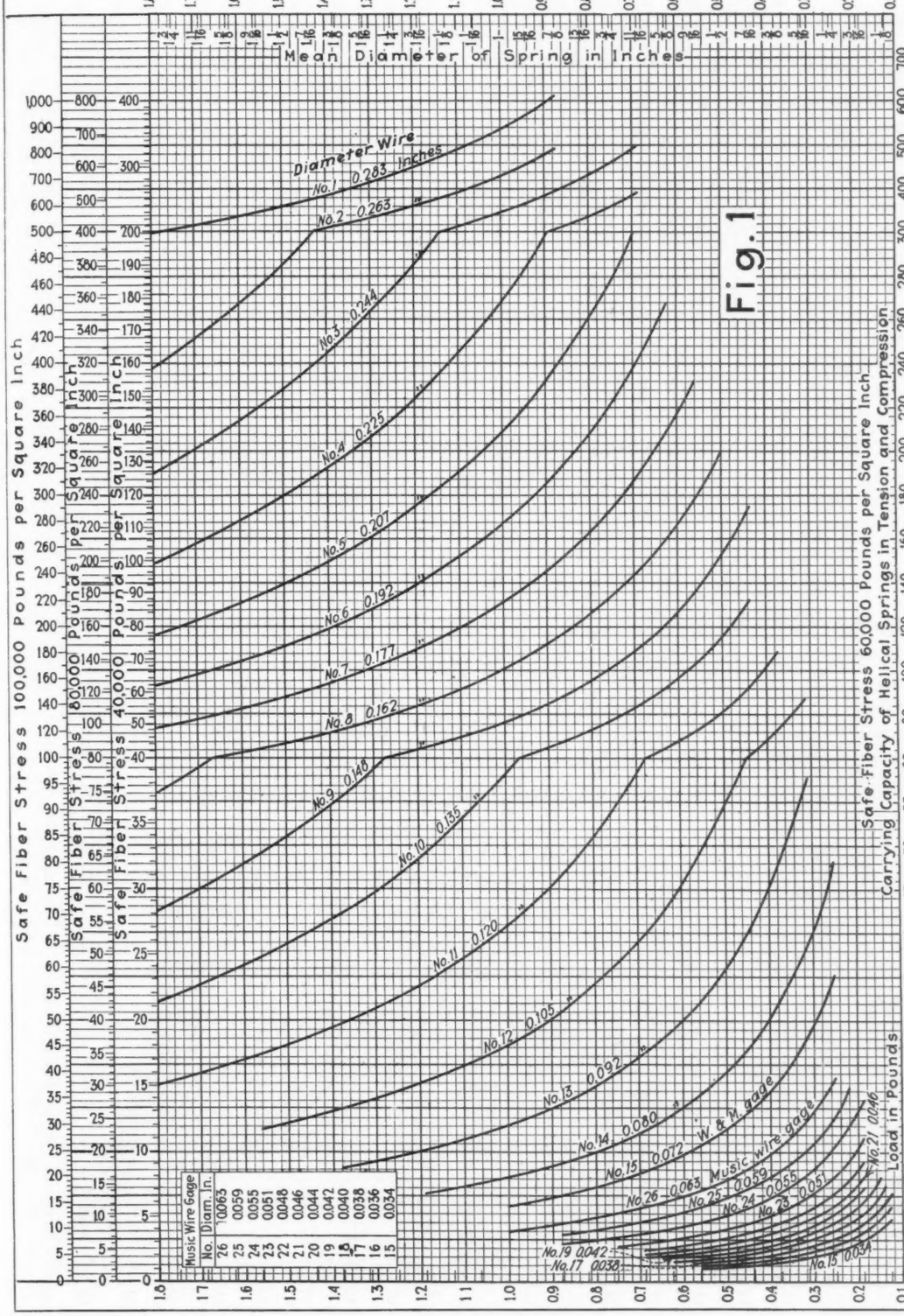

Fig. 1

Accompanying charts give the carrying capacity and deflection of helical springs of round wire in tension and compression and cover a large percentage of the springs used in machinery of medium size.

Curves in the body of the charts represent the size of wire from which the spring is to be made. For wire diameter of 0.069 in. and smaller the charts refer to music wire sizes. Above this size they refer to W.&M. gage spring steel wire.

Direct readings for load or deflection are made by using the lower scale for 60,000 lb. per in. safe fiber stress. If the safe fiber stress is 40,000, 80,000 or 100,000 lb. per sq.in. the values are read on the upper scales.

The formulas upon which the charts are based are:

$P = \pi d^3 S \div 8D \qquad F = \pi S D^2 \div Gd$

P = Total safe load in pounds
F = Deflection per coil in inches
S = Safe fiber stress in lb. per sq.in.
G = Torsional modulus, 11,500,000
d = Diameter of wire in inches

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Capacity and Deflection of Helical Springs

D = Mean or pitch diameter of spring (outside diameter of spring minus diameter of wire).

The following example illustrates the use of the charts: Problem, to design a spring 1¼-in. outside diameter that will carry a load of 52 lb. when compressed to a solid height of 2 in. when the allowable unit stress is given as 60,000 pounds per square inch.

Referring to chart for the carrying capacity, Fig. 1, it will be seen that No. 10 (0.135 in. dia.) W.&M. gage wire should be used.

1.250 — 0.135 = 1.115 in. mean spring dia.

From the chart for deflection, Fig. 2, using 1.115 in. mean diameter and No. 10 (W.&M.) wire, the deflection is 0.151 in. for each convolution in the body of the spring.

2 in. ÷ 0.135 in. = 14.8, which indicates that there are to be 14 coils in the spring of which 12 can be assumed to be active.

The total deflection for 12 coils would be 12 × 0.151, or 1.81 in. The free length equals the 2 in. solid height plus 1.81 in. or 3.81 inches.

Safe Fiber Stress 100,000 Pounds per Square Inch
Safe Fiber Stress 80,000 pounds per Square Inch
Safe Fiber Stress 60,000 pounds per Square Inch
Safe Fiber Stress 40,000 pounds per Square Inch
Diameter Wire Inches
No. 1 0.283
No. 2 0.263
No. 3 0.244
No. 4 0.225
No. 5 0.207
No. 6 0.192
No. 7 0.177
No. 8 0.162
No. 9 0.148
No. 10 0.135
No. 11 0.120
No. 12 0.105
No. 13 0.092
No. 14 0.080
W. & M. Wire Gage
No. 15 0.072
No. 16 0.036
No. 17 0.038
No. 18 0.040
No. 19 0.042
No. 20 0.044
No. 21 0.046
No. 22 0.048
No. 23 0.051
No. 24 0.055
No. 25 0.059
No. 26 0.063
Music Wire Gage
No. 15 0.034
Mean Diameter of Spring in Inches
Total Deflection in Inches (Per Coil)
Safe Fiber Stress 60,000 Pounds per Square Inch (Torsional Modulus 11,500,000)
Deflection of Helical Springs in Tension and Compression

Fig. 2

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